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Forthcoming Events.

NOVEMBER 10.

British Foundrymen's Association (London Branch).—"Physical Properties of Cast Iron," by F. J. Cook, Birmingham.

NOVEMBER 11.

British Foundrymen's Association (Scottish Branch).—"Presidential address by J. King, Glasgow, and paper on "Warping in Castings," by R. R. McGowan.

NOVEMBER 21.

British Foundrymen's Association (Sheffield Branch).—"Inexpensive Pyrometers," by C. E. Foster, Letchworth.

NOVEMBER 25.

British Foundrymen's Association (Birmingham Branch).—"Fans for Cupolas," by E. L. Joselin, Birmingham.

NOTES AND COMMENTS.

The Uses and Limitations of Malleable Cast-Iron.

Malleable-iron castings have fought much severe and maintained opposition in the past, and even to-day there are many directions where they might be applied were the essential features and limitations of the material more generally understood. It is difficult to impress those upon engineers and other users of castings; in fact, they are often only partially appreciated by many malleable-iron founders themselves. It is generally admitted that properly designed malleable castings are, within limits, often better than wrought iron and steel stampings, as regards tensile strength. This quality will vary according to the section of the casting, the thin sections giving relatively the higher figures and the thick sections the lower. Over 30 tons per square inch tensile strength can be obtained in the thin sections of a good malleable iron casting, with up to 16 or 18 tons for the thick sections, say, up to 1 in. in thickness. The maximum tensile strength, however, should not be aimed at, as this is usually accompanied by hardness—at the expense of the desired ductility of the castings. The strength decreases relatively with increase of the thickness, and therefore the best results, taking into consideration the amount of material used and the strength obtained, are got with sections of $\frac{5}{8}$ in. or less. There are, of course, occasions when the ductility of malleable cast iron justifies its use for sections as thick as two or three inches, but if strength is also required, the material will not be able to compete with steel. In this connection it may be mentioned that a test bar cast and annealed in the normal way may fall well below the strength of the casting, if the former is of materially thicker section. For example, the usual 1-in. square test bar, if split longitudinally, will show under the microscope a series of shrinkage cracks that destroy the continuity of the metal. Such a bar, obviously, would not be relatively as strong as a thin section of casting without such defects; and while the bar might closely indicate the quality of the iron as compared with other melts, it would not be representative of the casting.

Design Limitations.

It is most essential, in designing for malleable-iron castings, to remember it is a material distinct from grey cast-iron or wrought iron; therefore, what serves for one or other of these may be quite unsuitable for malleable. In the first place, as previously indicated, there is a size limit to the section which can advantageously employ malleable cast-iron; cast steel is the better material for thicknesses over 1 in. or so, particularly where the black-heart process is employed for the malleable cast-iron. Since the metal as cast is a white iron, the shrinkage during cooling is considerable, and in thick sections this is relatively a more serious matter than with thin sections. On account of the weak crystallisation which characterises designs with sharp angles (a characteristic common to all classes of castings) these must be avoided. Consequent on the foregoing features, plain, rectangu-

lar and circular sections are weak, while, also, considerable irregularities of section should be avoided, as in grey-iron castings. It is generally possible in designing a pattern to substitute a ribbed or flanged section for a plain or solid one, or a hollow or tubular section for a solid round. A star-shaped section might replace a solid square, with advantage, both as to weight and strength, the object being in all cases to keep the thickness of each part as nearly as possible to one size. But in designing it is very essential, while lightening the section to give even thicknesses of metal, not to introduce those features in the way of stiffening ribs, etc., which cause shrinkage strains even in grey-iron castings.

There is one point in connection with design which it is important to note well. The use of fillets in all sharp angles is a necessity, in order to avoid bad crystallisation effects; but a common error is to make those too liberal in size. To introduce too large a fillet in an angle overcomes the crystallisation defect, but too often at the cost of creating a thick section at that point, which involves the weakness of a part subject to shrinkage trouble, through remaining fluid longer than the rest of the casting. In the general run of malleable-iron castings a quarter of an inch fillet radius is quite sufficient to serve the purpose, while not unduly thickening that section of the casting. An examination of a well-designed agricultural machine employing malleable cast-iron (and this is an increasingly popular direction for the use of the metal) will show in what way lightness and strength may be secured. What might, at first glance, appear unnecessary refinements in the way of recessed portions and seemingly ornamental sections, are really the result of designing for a uniform thickness of metal. Here it is that malleable cast-iron has an advantage over wrought iron for such uses; for the latter can often only secure the necessary dimensions of parts required to give stiffness, by means of solid sections, with a corresponding increase of weight.

Malleable-Iron Castings under Severe Tests.

The motor-car industry promised a very fine opening for malleable-iron castings, and they are employed for such work to a considerable extent, the cost factor enabling them to compete satisfactorily with cast steel. But in this work the limitations of the material should be carefully considered. Where the thickness of section is small malleable cast-iron is quite well employed; but its reduced strength in thicker sections places it at a disadvantage when compared with steel. Some little while ago tests were made by an American firm to demonstrate the inferiority of malleable cast-iron against steel, when it was shown that the former in a given test-piece gave only about 20 tons per square inch tensile strength, elastic limit about 13 tons, and elongation 12 per cent. on 2 in.; while cast steel gave 33 tons per square inch tensile strength, 17 tons per square inch elastic limit, and 32 per cent. elongation on 2 in. The vibration test, also, proved the cast-steel specimens to be far superior to the malleable cast-iron, while the latter gave results which were not by any means uniform in the different specimens. But, obviously, these experiments must not be taken to condemn malleable cast-iron for motor-car construction, so far as suitable sections are concerned; for 20 tons is well below the representative figure for good material of correct section. Either the specimens were not of first-class quality, or the section was too thick for the material, which would give a quite erroneous idea of the qualities of correctly designed and sectioned "malleable." The case, however, is sufficient to clearly indicate one, at least, of the limitations of malleable cast-iron for such work; and it is not in the interests of the trade that it should be pushed for unsuitable or doubtfully suitable uses. There is a large enough scope for it without trespassing on ground that is more legitimately covered by other materials; and when engineers (and also founders) come to understand better what malleable cast-iron can do, it will be used for a great variety of purposes that at present employ, with doubtful success or at unnecessary cost, such materials as grey cast-iron, wrought iron or cast steel.

The Choice of "Malleable" Mixtures.

In choosing the class of malleable cast-iron for a special purpose, it is important to bear in mind the qualities required. The fact that a variety of qualities and classes of the metal can be produced is liable to be overlooked, and hence, when a metal with low tensile strength but considerable ductility is applied for purposes where strength is the essential, the material gets a bad name. For such purposes as cast gears, maximum strength is obviously the most important feature, and this may be sought at the expense of elongation. For other work, however, which is not liable to much strain, but where brittleness must be avoided, the tensile strength may be sacrificed in the interests of ductility. Opinions differ greatly as to the different mixtures suitable for different purposes, each founder having his own particular fancy for special work. The subject is too big to deal with at the moment; but it may be remarked that by varying the mixture and the heat treatment, as high as 34 tons tensile strength may be obtained, with practically no elongation, or elongation may be raised to 9 or 10 per cent., with tensile strength of only about 15 tons. Here the judgment of the founder is called into play.

Electric Furnaces and the Wealth of Nations.

In a recent Paper on "Electric Furnaces," by Mr. Carl Hering, the author refers to the effect which the development of the electric furnace is likely to have on the wealth of nations:—

Sweden, one of whose national products for many generations was the famous Swedish iron, has for some time past been losing this important industry owing to the greatly increased cost of charcoal. But owing to the enormous water powers in that country, and the generous and wise aid of its parental Government in developing them, Sweden will now be able to again recover that important national industry by means of the electric furnace, which requires only a fraction of the charcoal that the blast furnace does, and which enables the iron to be converted directly into refined steel of considerably higher money value.

The Government of Sweden is about to make available 600,000 electrical h.p., a large part of which will be used for reducing iron. Electric furnace reduction of iron will save about two-thirds of the carbon consumption, only one ton of charcoal instead of three per ton of iron being consumed by the electric furnace. The escaping gas is three times richer, as it contains no nitrogen and is only one-eighth in amount; hence, correspondingly less heat is carried off by it. Finely-powdered ore can be used without briquetting, and there is less labour cost and less cost of erection. Norway's industries will no doubt also be affected by the electric furnace. Its barren, rocky western coast, unfit for most other purposes, is admirably adapted for electric furnace industries, on account of its numerous easily available and nearly constant water powers located close to the coast, where

the products and raw materials can be cheaply despatched by water. As the shipping will probably for ever be open to normal competition and beyond the control of railroads, transportation costs can always be relied upon to remain reasonable.

Canada and the States along the Pacific coast, which abound in water powers and mines, but have no cheap coal, will no doubt also be greatly benefited by the electric furnace methods; always provided, of course, that Nature's generous gift of water power is not allowed to become monopolised by private interests, whose charges for power are governed only by the rule to charge "the highest price that the traffic can bear." The developments of the electric furnace industry will depend greatly on whether or not the Governments can keep control of the water powers and regulate the charges. Existing power plants would no doubt find it profitable to encourage the use of their power for furnaces, by offering reasonable and attractive rates, with an assurance of their permanency.

A comparison of the costs of *electric heat* and *fuel heat* depends so largely on local conditions, that a general comparison would not be of much value. But there are certain important characteristic differences between the two which can be compared in a general way. In the diagram, Fig. 1, let the horizontal distances represent costs and the vertical ones tempera-

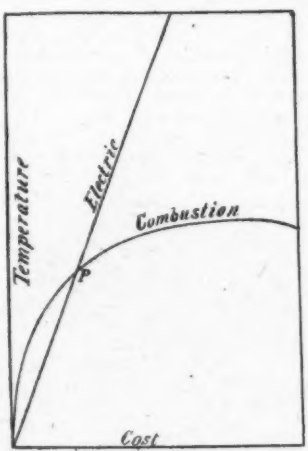


FIG. 1.—COMBUSTION COST CURVES FOR ELECTRIC AND FUEL HEATING.

tures, and let the curves represent the costs of heating a given body, say, a ton of steel, at the various temperatures, neglecting such modifying factors as latent heats and variations in the specific heats. The general shapes of the curves for the *combustion heat* and the *electric heat* will be approximately as shown. For the combustion heat the costs for the lower temperatures will be seen to be quite small, but as the temperatures become high the costs increase much more rapidly, so much so that the curve finally becomes horizontal and even falls again; hence it has a maximum point. Beyond this point the volume of gases in the blast becomes so great that the gases carry off the heat more rapidly than the fuel can supply it; hence they actually reduce the temperature by chilling the fuel or the gases.

In all combustion furnaces the gases must necessarily leave at least at the temperature of the body which is heated, and generally they leave at a far higher temperature; therefore all the heat carried off by them is waste, except when it is partially recovered by regeneration. Another reason for such a maximum temperature is the dissociation of the gases, which means that the components cease to combine, hence cease to generate heat.

The corresponding curve for electric heat is roughly a straight inclined line, as shown; in other words, the cost increases at an approximately constant rate, and there is no maximum point, as long as there exists a material to carry the current. The two curves always intersect each other, and at this point P the costs are equal.

It will readily be seen, therefore, that low-temperature heat is usually generated more cheaply by combustion, while for higher temperature heat it is cheaper to use electricity. Also, for temperatures above the point P the cheapest way would be to combine the two, using combustion heat for the low temperatures (below the point of intersection) that is, for melting or preheating cold charges, and electric heat for the higher temperatures (above the point P). This is now common practice in the electric steel industry, the melting being done by combustion heat, the hot metal being then run into the electric furnace for further treatment. If it were possible to so construct an electric furnace that both kinds of heat could be applied in the same furnace, then the advantages and the economy of this ideal combination would be fully realised.

The relations of these two curves will, of course, vary with local conditions, and their shapes will also change somewhat; they should, therefore, be considered as showing only the general characteristics. Where water power is cheap and fuel expensive, the straight line will be steeper and the other one will rise less steeply and be more flat at the top, while in localities where there is no water power, and where coal is cheap, the curved line will rise more steeply.

The maximum temperature for the combustion curve in commercial furnaces is in the neighbourhood of those used in the iron industry, namely, between about 1,500 degrees to 1,900 degrees C. (2,700 degrees to 3,400 degrees F.). The maximum for the electric arc furnace having carbon electrodes is the volatilisation point of carbon, namely, 3,500 degrees to 4,000 degrees C. (6,000 degrees to 7,000 degrees F.). This is just about double, and it is far greater than is necessary for most metallurgical purposes.

The chief advantages of electric furnaces over those of the combustion type are too well known to require more than mention here. They include the neutral atmosphere, that is, the heat is neither oxidising nor reducing; the possibilities and ease of obtaining the higher temperatures; the rapidity of heating; metallurgical cleanliness (that is, no impurities like ash, sulphur, etc., introduced by the heating process); no losses in waste gases; greater possible economy in the heat losses; the heat may be generated in the material itself (in resistance as distinguished from arc furnaces); the heat may be generated at the bottom instead of at the top, at least in some resistance furnaces; ease, accuracy, and reliability of control and regulation; greater uniformity and reliability of product; greater output for a given size of furnace or a smaller furnace for a given output; reduction of labour and sometimes of the plant; incidental advantages such as better castings due to greater fluidity of metal, and less waste of metal.

MR. E. ALLEN, of Edgar Allen & Company, Limited, Imperial Steel Works, Tinsley, Sheffield, has presented that city with a medico-mechanical institute in order that working men may obtain the advantages of the treatment. Mr. Allen has also undertaken to defray the expenses of carrying it on during the next three years.

Temperature Influences on Carbon and Iron.*

By E. Adamson (Sheffield).

The author suggested, in his Paper of May, 1906, that there is a wide field for investigation in regard to carbon in pig-iron, and he now proposes to give data derived from observations in works practice, which go far to show that the determination of silicon alone is not sufficient in the chemical grading of pig-iron.

In the Paper referred to the author suggested that the conversion of graphite was due to temperature rather than to silicon, and stated he agreed with Sir Robert Hadfield's statements that under certain conditions carbon would be precipitated even if no silicon

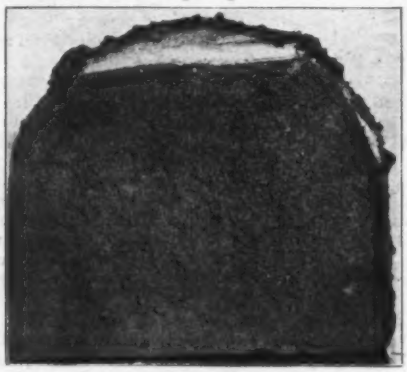


Fig. 1.

were present, the conditions being temperature and time, and the percentage of total carbon thereby governed independently of the silicon, sulphur, phosphorus, and manganese present. It has long been known that with Swedish white iron, which is usually cast in chills, if the carbon is sufficiently high and the pigs cast in sand, the fracture will be grey. It is only necessary to mention the further facts that carbon separates out as free carbon when high-carbon steel is forged at a low temperature; and that in a material of the following composition Charpy and Grenet obtained a separation of 1.87 per cent. graphite, even when it was quenched at 700 degrees C.

	Per cent.
Carbon	3.60
Silicon	0.07
Sulphur	0.01
Phosphorus	trace
Manganese	0.03

Foster, at a later date, melted steel in the presence of carbon, and obtained a grey fracture in material of the following composition:—

	Per cent.
Total carbon...	4.6 5
Graphitic carbon	2.136
Silicon	0.098

The section of this sample was exceedingly thin, Fig. 8 being a photograph 9½ times magnified. It was purposely "chilled" in cooling, but, in spite of the thin section, it did not cool white, being quite grey, owing to the high total carbon.

* Paper presented before the Autumn Meeting of the Iron and Steel Institute, in London.

It is not difficult to produce in the blast furnace very open grey iron containing 0.40 per cent. of silicon, and grey iron containing 0.20 per cent. of silicon, and the author has made to specification refined iron with very grey fracture, containing silicon 0.40 per cent., as also an iron with silicon 0.15 per cent., having a hard, mottled fracture—such pigs being 4 by 4 in. in section and cooled in the ordinary way.

These facts show that carbon is precipitated as free carbon virtually in the absence of silicon, and in the author's opinion this precipitation, in the case of the manufacture of pig-iron, primarily depends upon the original temperature to which the iron is raised in the blast furnace.

The saturation point of carbon and iron has generally been taken as about 4.25 per cent., but as far back as 1846 Karsten considered iron could take up 5.93 per cent. of carbon. Later, Moissan found it could take up 6.76 per cent., and only recently Girod obtained 7.90 per cent. in his furnace, but he considers that the iron which contained this in the cold state held over 8.00 per cent. in the molten state, which confirms the author's contention. The differences in these percentages of carbon are due to the temperature to which the iron had been raised, and the time it remained at high temperatures in contact with carbon, and it is now generally accepted that

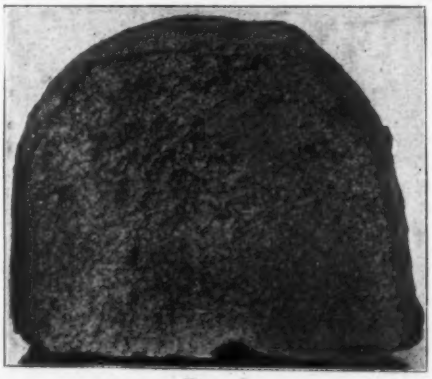


Fig. 2.

the higher the temperature in the blast furnace the higher the carbon in the product—within limits—for it is well known that cold-blast iron is lower in total carbon than hot-blast, although the full force of this fact has perhaps been overlooked. What this amounts to is that the temperature of the furnace decides the fracture of grey pig-iron as well as of the lower grades, regardless of the contents of silicon, sulphur, phosphorus, and manganese. This will be more apparent from the following Table I., taken from the author's Paper of 1906, which gives the complete analyses, with increasing silicon, from ordinary hematite irons taken haphazard from the daily make of a furnace, and it will be observed that whilst the silicon varies from 0.67 per cent. to 5.85 per cent., the fracture is all No. 1.

TABLE I.

No.	Fracture.	T.C.	G.C.	C.C.	Si.	S.	P.	Mn.	Remarks.
1	No. 1 ...	4.23	3.62	0.61	0.67	0.026	0.040	1.40	—
2	No. 1 ...	3.65	3.08	0.57	1.46	0.040	0.030	0.72	—
3	No. 1 ...	3.76	3.20	0.56	2.14	0.038	0.031	0.78	—
4	No. 1 ...	3.23	2.83	0.40	3.93	0.030	0.040	1.30	Very large flakes.
5	No. 1 open	3.67	3.50	0.17	4.98	0.034	0.041	1.34	Same cast. Open and close No. 1 fractures.
	No. 1 close	3.67	3.49	0.18	4.63	0.034	0.041	1.34	
6	No. 1 ..	3.14	3.02	0.12	5.85	0.033	0.043	1.00	—
7	No. 1 close	3.28	2.22	1.06	0.35	0.026	0.020	0.07	Supplied by Sir R. A Hadfield.

Table II. is taken from the author's discussion of Levy's Paper,* in which the silicons vary from 0.20 per cent. up to 4.83 per cent. in grey irons.

TABLE II.

No.	Fracture.	T.C.	Si.	S.	P.	Mn.
1	White alloy ...	4.60	0.79	0.018	0.016	1.26
2	Grey No. 1	4.23	0.67	0.026	0.040	1.40
3	White	4.20	0.20	0.020	0.020	trace
4	Grey No. 1	3.50	2.00	0.030	1.560	0.30
5	Grey No. 1	3.28	0.35	0.026	0.020	0.07
6	Grey close	2.95	0.95	0.065	0.280	1.65
7	Grey	2.90	4.83	0.010	1.050	0.61
8	Grey close	2.60	1.70	0.030	0.080	0.08

In these analyses of commercial pig-irons the only explanation of the difference in fracture, total carbon, and silicons is primarily due to the temperature of the furnace, and also to its burdening and general working, which are the primary causes of the several conditions of free carbon such as are found in the grades of grey pig-iron, Nos. 1 to 5, regardless of the contents of silicon, sulphur, phosphorus, and manganese.

The author has referred to several conditions of free carbon, of which it is practically impossible to obtain complete separations or photographs to show the true

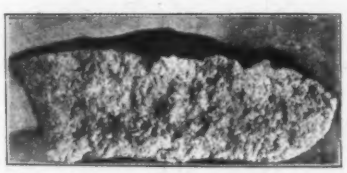


FIG. 3.

crystallisation, as the surface of a fracture of a pig is so uneven, and thus cast shadows which destroy the true structure as seen by the eye. It is also equally impossible to get an adequate surface under the microscope to give a true indication of the different conditions of free carbon found in pig-iron, but they can approximately be described as follows:—

(A) Very fine graphite liberated at low temperatures, and such as is generally found in a mottled iron, and Nos. 5 and 6 cold-blast irons. This appears to be the first stage of free carbon when it is separated as such in a large section of metal; the larger the section the greater the percentage of separation, due entirely to slow cooling, and such as would be largely shown when the late Sir Lowthian Bell cast a 6-ton block of white iron to prove that by slow cooling there would be a separation of graphite in the centre. This condition of graphite is shown in Fig. 1.

(B) This is another variety of graphite, showing a crystallisation not unlike frost on glass. This can be produced from white iron by annealing for a long period at a high temperature, or in hard grey iron by very slow cooling. This variety of graphite is also produced in pig-iron at medium temperatures, and the peculiar formation is most pronounced in irons low in phosphorus, and also frequently in the case where rich hematite iron and steel scrap are melted together. This variety is seen in Fig. 2 and Fig. 3, the former being a fracture of pig-iron, and the latter from "rich" hematite and steel scrap melted together in about the proportion of half and half.

(C) This variety is the well-known large flake of graphite found in open soft irons. It is formed at high temperatures regardless of the constituents in pig-iron, as shown in Table I. It is also the most difficult of the three varieties to oxidise or burn. This most refractory condition is that disclosed in a fracture of No. 1 pig-iron showing "kish," and this condition varies from that of the most refractory nature known as "kish" down to the smaller structure as seen in a No. 3 pig-iron. The fractures are shown in Figs. 4 and 5, which are photographs of phosphoric and non-phosphoric pig-iron.

None of these varieties of free carbon are necessarily completely destroyed on melting, even under slightly oxidising conditions, as in the cupola, for whilst it is generally assumed that melting iron in the cupola lowers the grade, this entirely depends upon the total carbon and its condition in the original pig. The author has proved in works experience that it is possible to reproduce the grade under good ordinary

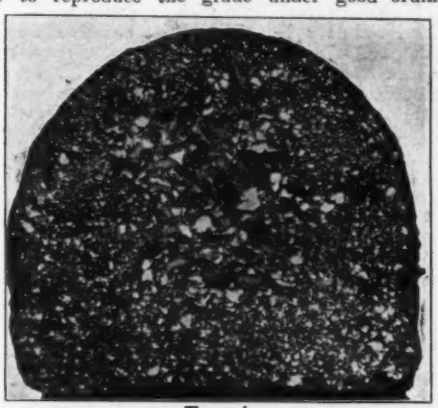


FIG. 4.

conditions of melting, independent of the influence of the other metalloids present.

These crystallisations or formations of free carbon or graphite carbon are difficult to describe, as it is not easy to obtain samples in a suitable form to give a true indication of the appearance of the fracture containing these varieties of carbon, but all these forms are found, and are most apparent when turning a furnace off hot-blast iron on to cold-blast iron, and *vice versa*. Under these circumstances these three varieties of carbon make their appearance in a very decided form, and when thus produced it is not difficult to understand that temperature is the primary cause of their change of form.

The author believes that cooling curves of iron containing each of these three different forms of free carbon would vary in the position and character of the critical points, but it will take a considerable time to obtain the particular fractures of iron sufficiently alike in composition. As soon as such fractures can be obtained, the author will give particulars.

With regard to these different forms of free carbon, Moissan has done some valuable work, and has pro-

* "Journal of the Iron and Steel Institute," 1910, No. 1, p. 421.

duced several varieties of graphite or free carbon in the electric furnace. Whilst not able to give complete cooling curves of these varieties of carbon and iron, the author has been able to obtain cooling curves from a No. 1 hematite and an alloy made from Swedish white iron and high-grade ferro-silicon melted together to give approximately the same analysis as regards total carbon, etc. Practically the two extreme forms of carbons found in grey and white pig-irons are found in these two samples. These curves are given in Fig. 6, A and B, and the analyses are as under:—

	A.	B.
	Per cent.	Per cent.
Total carbon	4.20	3.90
Graphitic carbon	3.62	trace
Combined carbon	0.58	3.90
Silicon	1.02	1.04
Sulphur	0.018	0.010
Phosphorus	0.022	0.018
Manganese	0.53	0.22
Fracture at start	No. 1.	Practically white.
Fracture at finish	Grey porous.	Close grey.

Dealing first with B, this iron was chilled on cooling to produce a white fracture, and the curve shows the first arrest at 1,216 degrees C., the second arrest at 1,140 degrees C. (known as separation of graphite), and the third arrest at 712 degrees C., of Ar.3.2.1. This is quite in accordance with expectations. Sample A was an ordinary No. 1 hematite obtained from the Millom and Askam Hematite Iron Company, pieces of which were cut off sufficiently small for use in a small crucible to obtain the curves—both metals being raised to 1,500 degrees C.—and whilst the total carbon (4.20 per cent.) was 0.30 per cent. higher than the B alloy, the first arrest took place at 1,317 degrees C., 101 degrees C. higher than the companion alloy; the second arrest occurred at 1,090 degrees C., and was comparatively small as compared with the second arrest of the alloy B, suggesting that a large portion of the carbon had not dissolved in the iron even in the molten state; whilst the third arrest, at 695 degrees C., was to be expected. This third arrest of A is also different from that of B, but does not come within the scope of this Paper. Much more work will probably have to be done before it can be explained. It will be noticed, however, that in the alloy B, after each arrest, the cooling comes back to normal; but in the case of the hematite pig-iron, after the first arrest the curve never comes back to normal, and there is a permanent expansion, as will be seen on Fig. 7, the dotted curve being A.

The original fractures of A and B were a very open grey and a practically white iron respectively, whilst the fractures on cooling were open grey and close grey respectively. The peculiarity of the first fracture A on cooling was that the metal showed numerous "draws" or small "pipes" from the top surface, and the crystallisation throughout the A fracture was very like the form of "primary octahedral crystallites" just before being freed, such as are frequently found in the heart of thick parts of iron castings. Fracture A has an appearance something like Fig. 8.

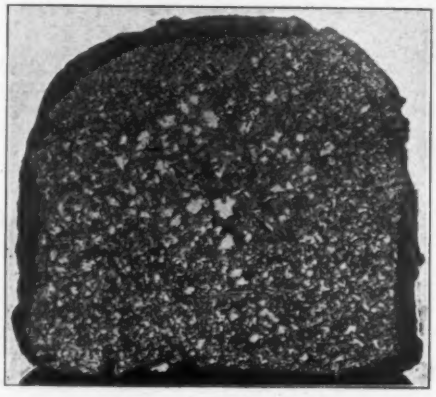
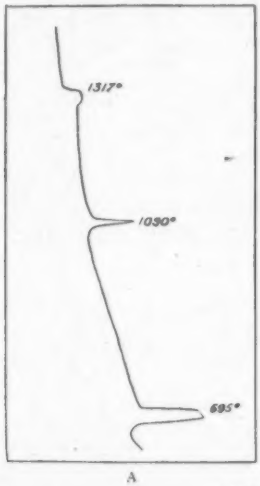
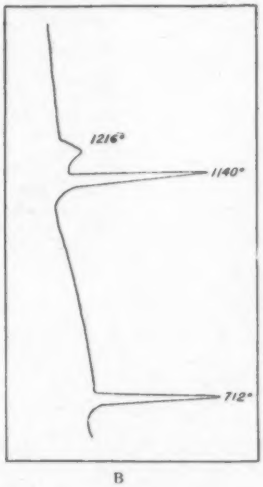


Fig. 5.



A



B

Fig. 6.

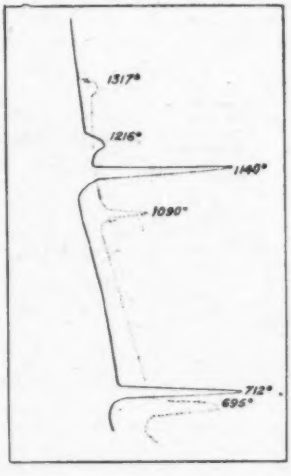


Fig. 7.

The fracture of the B sample on cooling was perfectly solid throughout, was very tough, being slightly malleable, and when fractured showed a strong, close-grained iron.

In the discussion of Levy's Paper the author drew attention to the fact that the Phase Rule, upon which Levy relied for a number of his conclusions, would not apply in actual works practice; that is, that it would not apply to all grades or fractures of iron,

for in the author's opinion the Phase Rule depends upon the iron being white when cold, or probably not further developed in free carbon than the A variety described above by the author, at the commencement of any experimental cooling curves, whilst it will be seen from the tables quoted above that this is not the case even in very low-silicon iron. In his reply to the author, Levy quoted several points of solidification, but none of these could be confirmed by the temperatures given on the author's curve A now presented. The points of solidification of Carpenter and Keeling, and Wüst, quoted by Mr. Levy, are based upon white iron alloys or containing fine graphite, and the author is sure that the gentlemen quoted would readily admit that the Phase Rule cannot be strictly applied to works practice in the case of grey high-carbon irons, for whilst A has the higher total carbon, viz., 4.20 per cent. against B 3.90 per cent., the first arrest of the former occurs 101 degrees C. higher, whereas, according to the Phase Rule, A should have been lower than B, and in A the second arrest due to separation of graphite largely disappears. The author's explanation of the difference in curves A and B is that the more refractory forms of graphite, such as are found in pig-iron and produced at high temperatures, do not entirely dissolve in iron when in the molten state, and that some of the more refractory forms of graphite, particularly of the "kishy" character, are held in suspension in molten metal. In his Paper of May, 1906, the author referred to a separation of graphite before solidification. C. A. Edwards very ably describes this phenomenon in his notes on "The Nature of Solid Solutions."*

The author's highest total carbon is 4.20 per cent., and the lowest points of solidification given by Carpenter and Keeling are carbon 3.98 per cent. 1,171

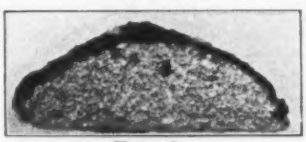


FIG. 8.

degrees C., 4.37 per cent. 1,136 degrees C.; the second of these points, 1,136 degrees C., is from an alloy with a higher total carbon than the author's curve A, and Levy further explains that an increase in carbon beyond a certain point is accompanied by some rise in the point of solidification. The author's curves, however, are well within the limits of carbon mentioned by Levy to which apparently the Phase Rule applies, and curve A proves that it is not an increase of carbon only which raises the point of solidification, but, what is of more importance, the conditions of the carbons as determined by the temperature to which the iron has been raised in contact with carbon, in which time also plays a prominent part, thus interfering with the application of Phase Rule as to total carbon contents, by causing a decrease in what may be termed "effective" carbon when applied to Phase Rule curves. The "non-effective" carbon or refractory graphite also causes a permanent expansion.

On referring to Turner and Hague's Paper,† curves 4 and 5, with silicon 0.97 and 1.19 per cent. respectively, are nearest in silicon contents to the author's curves A and B. In general principles these curves, Nos. 4 and 5, confirm B, with the exception of the first arrest, which takes place in 4 and 5 at 1,247 degrees C. and 1,244 degrees C. respectively, whilst B occurs at 1,216 degrees C., making it in keeping with 4 and 5, and the slight variation is probably due to the difference in total carbon, which is as follows:—

	T.C.	G.C.	C C.	Si.
	Per cent.	Per cent.	Per cent.	Per cent.
Turner's No. 4 curve...	2.56	0.23	2.33	0.97
Turner's No. 5 curve...	2.70	1.32	1.38	1.19
Adamson's B curve ...	3.90	trace	3.90	1.04

In the above three analyses silicon has been included to draw attention to the fact that under no conditions can it be said to control the percentage of combined carbon or graphite, and this is confirmed by Turner and Hague's Table I. on p. 81, a careful study of which will show that it cannot be claimed that the percentage of silicon controls the percentage of combined carbon, or the graphite, or the ratio of one form of carbon to the other. Under precisely the same conditions of temperature and time, additions of silicon may even show fairly regular variations in the carbons, but under the same constant conditions phosphorus and manganese would do the same.

The curve A is of quite a different character from any of the seventeen curves given by Turner and Hague, even although some of the latter contain as much as 1.93 per cent. graphite in a total carbon of 2.77 per cent. Turner and Hague stated they found difficulty in adding silicon to iron containing carbon 3.04 per cent. by using 50 per cent. ferro-silicon alone, and they therefore prepared a special alloy to enable them to add silicon in varying percentages to white iron. This special alloy was made with over-blown steel, and contained about 20 per cent. silicon. By means of such material the authors obtained their alloys from which the seventeen curves were taken. In the present case the B alloy was made from Swedish white iron containing 4.00 per cent. carbon, and it was not found difficult to introduce silicon 1.04 per cent. by means of 50 per cent. ferro-silicon, thus confirming the author's previous experience as stated by him in discussing Turner and Hague's Paper. In that Paper the authors claim "that the carbon in the washed iron prevented the silicon from entering," but this is not confirmed in the case of the present B alloy made from iron containing over 30 per cent. more carbon than was used for the alloys for the seventeen curves. Under the circumstances stated, the author is sorry he cannot agree with the conclusions of Turner and Hague, and suggests that temperature and time are important factors. Curve A was made from a natural blast-furnace product.

The difference between Turner and Hague's B curves and curve A can be explained in the difference of total carbon and also the condition of the free carbon or graphite, chiefly the latter. The alloys of the seventeen curves varied from total carbon 2.26 per cent. to 2.95 per cent., most of them being within Professor Arnold's steel limits, and all were practically semi-steel; hence, with such low-total carbons there is small possibility, at the temperatures which would be used for dealing with these alloys, of producing any refractory forms of graphite, such as found in true cast iron. In curves A and B, however, of total carbon 4.20 per cent. and 3.90 per cent. respectively, these are the usual carbons of a non-phosphoric pig-iron, and therefore the natural product of the blast furnace; hence the irons have been subjected to the high temperatures of smelting, and are true cast irons.

* "Institute of Metals," No. 1, 1911, vol. v.
† "Journal of the Iron and Steel Institute," 1910, No. II. p. 85.

In none of Turner and Hague's curves, from the lowest percentage of silicon to the highest, does the first arrest occur higher than 1,247 degrees C., and all these curves, as well as curve B, after each arrest appear to fall back to practically the normal rate of cooling, whereas in curve A the first arrest is at 1,317 degrees C., or 70 degrees higher than the highest first arrest of Turner and Hague, and the A curve never comes back to the normal rate of cooling. This is explained on the author's suggestion that, with certain conditions or varieties of free carbon present, there is a certain percentage of non-effective carbon when dealing with cooling curves and their application to the Phase Rule; this ineffective carbon also causes a permanent expansion, apparently due to the swelling character of the graphite, thus confirming Moissan's observations. In curve A the effective carbon would appear to be up to about 2.00 per cent. on the basis of Carpenter and Keeling's figure of 1,443 degrees C. as the solidifying point of steel, as against their 1,171 degrees C. for an alloy of 3.98 per cent. total carbon.

The author has already referred to statements made in his Paper of 1906, in which he agreed with Sir Robert Hadfield in stating that under certain conditions carbon would be precipitated in the absence of silicon, and as a proof of this he is indebted to the Millom and Askam Hematite Iron Company for permission to use the following analysis :—

	Per cent.
Graphitic carbon	trace
Combined carbon	3.87
Silicon	nil
Sulphur	0.074
Phosphorus	0.037
Manganese	0.30

The fracture is hard mottled iron, and no doubt the cause of graphite being given as "trace" is that the grey part of the fracture was in the centre of the pig, and the proportion of graphite to combined carbon, whilst substantially true of the grey portion of the fracture, could not be accurately estimated over the whole fracture. This iron is a freak, it may never have been produced before, and may never be produced again; and whilst it is a natural blast-furnace product, no one would attempt to produce such an iron as a commercial product. Accidents sometimes, however, reveal the truth. This particular iron was produced by a slip of the burden of the furnace whilst running on rich high-grade iron. This produced a "chilling" effect, causing the fracture of the iron to be white, and only about 2 tons of this iron was made.

The facts stated in this Paper are of vital importance in considering the question of the grading of pig-iron, and to a large extent explain the objections of many in this country to complete change in the methods used at present to one of grading by practically silicon content only. The author has shown on several occasions that it is not possible to regulate tests by silicon only, and has no hesitation in saying that the fracture indication is quite as satisfactory as varying the silicon, if the user is fully conversant with fracture indications.

Continual experience in the use of pig-irons in the foundry shows that the same tests can be obtained within very wide ranges of silicon contents. Of course, if it is a question of commerce, there should be no objections to selling irons by silicon contents if this is demanded and full responsibility is taken by the purchaser; but when it becomes a question as to whether such a method of grading is the best, so as to be of the greatest use to the greatest number, the reply must be an emphatic negative, for it would appear that carbon and its various conditions, due, as shown, to influences entirely outside of analyses, is of primary importance.

Production of Molybdenum Steel in the Electric Furnace.

At the twentieth general meeting of the American Electrochemical Society, Messrs. E. T. Dittus and R. G. Bowman gave an account of an investigation carried out in the Colorado School of Mines. The use of a sulphide ore of so active a metal as molybdenum in connection with the manufacture of steel presents a number of problems. Foremost among these are the complete reduction of molybdenum without serious loss, the diffusion of the molybdenum through the steel to form a homogeneous product and the elimination of the sulphur from the steel. The process employed was one based on a reaction described by Mr. F. M. Becket in U.S. Patent 855157, and is believed to be new.

In the production of steel direct from ore in the electric furnace the removal of certain impurities, particularly sulphur, offers difficulties. The experimental work was done in an electric furnace which could be operated either as a Héroult furnace (two arcs in series on the top) or as a Girod furnace (two arcs in parallel on the top and a metallic electrode in the hearth). The capacity of the furnace was about 1,000 grammes of metal per charge, or approximately 2,000 grammes of raw charge. Single-phase alternating current at 60 cycles, 25 volts, was used, with an average amperage of 250. The iron ore employed was a good grade of hematite, the analysis being 66.06 per cent. Fe., 1.52 A_2O_3, 4.12 SiO_2, 0.04 P and 0.04 S. The ore was crushed to pass eight mesh (3mm.) and the fines were retained. A quantity of molybdenite from Yorkes Peninsula, Australia, was used, being practically pure MoS_2 with only a trace of impurity in the form of copper sulphide. Ferro-silicon was used with an analysis of 49.7 per cent. Fe, 50 Si, 0.005 S, 0.20 C. The ferro-silicon and molybdenite were ground to pass thirty mesh (0.85 mm.) and intimately mixed in the proper proportions to bring about the reaction:

$$MoS_2 + Si = Mo + SiS_2.$$

The proper amount of this mixture to give the desired molybdenum content in the steel was enclosed in a small paper tube and added to the bath of metal just before reduction was complete. There was considerable trouble in tapping, as generally the metal would not flow. Only one of the runs is here given. The charge consisted of 3,025 grammes iron ore, 660 coke, and 412 lime, the calculated iron content being 2,000 grammes. The length of the run was 1 hour 30 minutes, the mean amperes 200, mean volts 25, power 5 kw. A total of 1,700 grammes of metal was obtained. The calculated molybdenum content was 2.5 per cent. The analysis of the metal showed 0.62 per cent. C, 0.91 Si, 1.15 Mo, 0.08 P, 0.37 S.

The following final conclusions are drawn:

(1) Molybdenum steel can be made in the electric furnace by the direct reduction of iron ore and the addition of molybdenum in the form of molybdenite, MoS_2.

(2) Molybdenum steel of low sulphur content can be produced from molybdenite by the use of ferro-silicon as a desulphuriser.

(3) Molybdenum steel of low sulphur content can be produced from molybdenite in the form of low-grade concentrates by the use of ferro-silicon as a desulphuriser.

With regard to the design of a furnace for small scale operations, the experiments seemed to indicate that: (1) A tilting furnace would be more effective than a stationary furnace. (2) The tap hole on a stationary furnace should be made short, with a steep inclination. Ample provision for heating the tap hole should be made. (3) Tar does not make a satisfactory binding material for crushed magnesite.

Non-Ferrous Metals in Railway Work.*

By George Hughes, M.Inst.C.E., M.I.Mech.E.†

(*Continued from page* 600.)

Slide Valves.

Slide valves are made to the following composition:—

	Per cent.
Copper...	84.5
Tin	10.0
Lead	5.0
Phosphorus	0.5 (added as 15 per cent. phosphor copper).

Tensile tests taken normally and at a temperature up to 400 degrees F. do not indicate any particular loss in the strength of this alloy at these temperatures, as compared with the cold state.

Other mixtures containing as much as 13 per cent. lead have been used with fair results, whilst gunmetal valves of an alloy of 86 per cent. copper, 12 per cent. tin, 2 per cent. zinc, and therefore containing no lead, have not justified expectations under comparative tests in service.

The mixture used is made from half old worn-down valves and half new metal, the copper being obtained from clean scrap-plate shearings cut from old firebox plates. These plates are bought to specification and contain arsenic, 0.35 to 0.5 per cent., with other elements (exclusive of combined oxygen), not over 0.25 per cent. This mixture was adopted after trials to find the best wearing properties both of the valve and the cast-iron cylinder port faces. Such valves of varying designs, from the simple "D" valves to the balanced types, have given satisfaction, working under temperatures of from 450 degrees F. to 600 degrees F., in the steam chests. They do not fracture in service, and an unbalanced "D" slide valve $\frac{3}{4}$in. thick will run 1,000 miles with a wear of 0.035 in. on the face. The wear of the balanced valves is not so much as this, careful measurements showing (in the case of valves working in a vertical position, known as Back-to-Back Balanced Valves) a wear of 0.0055 in. per 1,000 miles run. These valves are allowed to wear down $\frac{5}{8}$ in. for both valves, the total mileage being 114,266.

Modern conditions of superheat have caused the question of valves to come again under revision. The author has pleasure in stating that he has had running for two years a pair of ordinary slide valves at a temperature of 600 degrees F., with only a wear of 0.013 in. per 1,000 miles. He has also just turned 20 engines into traffic with a modified form of slide valve for superheat. In the strict sense of the term these are slide valves, and, so far, have given good results. Slide valves are moulded in sand from plate patterns. Considerable care has to be exercised in moulding, rapping, and drawing the patterns, as the valves when cast must pass limit gauges of $\frac{1}{16}$-in. margin before proceeding to the machine shop for grinding on the face and to fit the buckles.

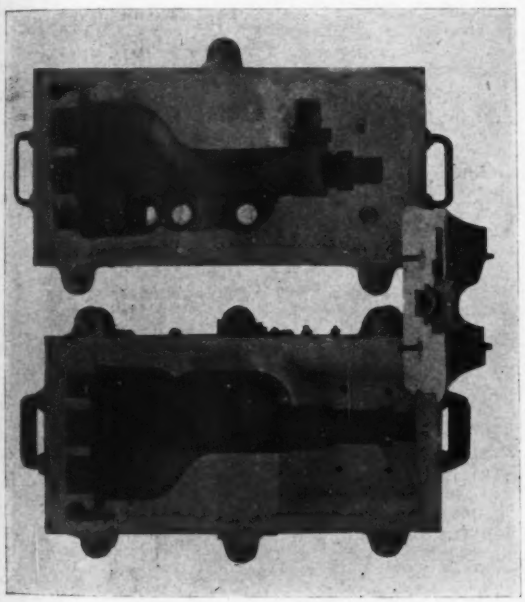


Fig. 2.—Mould for Injector.

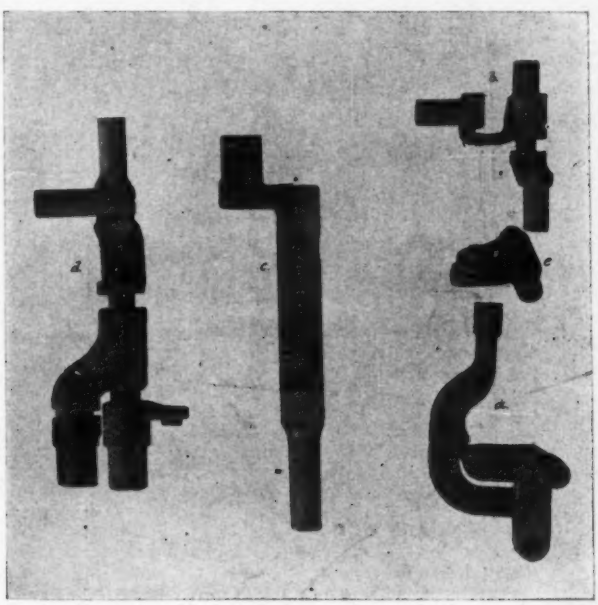


Fig. 3.—Cores for Injector.

Gunmetal.

This is made to the well-known Admiralty specification:—

Copper, 88; Tin, 10; Zinc, 2.

Certain work, such as valve seatings, bushes, steam regulator slides, and some slide valves, are cast in

* Abstract of Paper read before the Institute of Metals.
† Chief Mechanical Engineer, Lancashire and Yorkshire Railway.

this metal, though other less expensive alloys containing lead are used for bearing brasses.

The alloy casts clean and sound into green sand or skin-dried moulds, and should some of the constituent metals or scrap used be coated with scale entailing a tendency to oxidation, a small piece of phosphor copper may be added to clarify the whole, with good results.

The casting temperature, and the fairly rapid cooling of the casting in the mould, are important factors in the production of good castings, otherwise crystallisation becomes pronounced.

The following tests have been obtained:—

Tenacity, tons per sq. in. = 16.01 ; per cent. elongation 3 in., 10.1

This is an average of 28 tests.

Injector Metal and Fittings.

Copper, 84.0 ; Tin, 8.5 ; Zinc, 5.0 ; Lead, 2.5.

This metal has given good results in injectors, ejectors, gauge-cocks, and general details. It results in a clean casting, free from oxidation and scum in the intricate cores of the injector. The metal runs freely, and whilst the lead present may not appear to the mind of every one as necessary, it assists machining, and the author, feeling that he has no grounds for omitting it, would like to have some comments on this point.

Injectors give no trouble on the score of unsound castings in machining, and under steam tests and service.

Seatings and clacks require regrinding from time to time.

Tensile tests are good, averaging 14 tons tenacity with 11 per cent. elongation on 3 inches.

Moulding.

In moulding, many of the operations are common to all castings. The author does not propose to generalise upon the subject; it would involve too long a dissertation reiterating facts well known to all workers in non-ferrous metals, but he thinks that to place on record the moulding of an injector in detail, together with the illustrations, Figs. 2, 3, 4 and 5, will be useful. (The references in italics, *Figs. 12 to 19*, refer to the drawings, Fig. 4.)

The operation demands a pattern in four parts, numbered 1, 2, 3, and 4 (*Fig. 12*), and five boxes for the cores, lettered *a*, *b*, *c*, *d*, *e* (*Fig. 13*). Four parts are also required for the moulding box, these being lettered A, B, C, D (*Figs. 12 to 19*), and also a drawback lettered E (*Figs. 12 and 15*).

The first part of the moulding operation is to place the part pattern No. 1 on to the follow board marked 5 (*Fig. 12*), which is large enough to receive the box part A. This box part is fitted with projecting irons or fixed gaggers, *g* (*Figs. 18 and 19*), at each side, to carry the overhanging sand. The sand is rammed round the pattern, the seating for part pattern No. 2 being kept clear. As it is necessary to make a joint at this place, parting sand is put on where required (as shown in *Fig. 12*). Preparation is made at one end of this box for a pouring gate, *h* (*Figs. 12 and 14*), and when this is done, it is ready for box part B to be fixed on. This part is also fitted with projecting iron or fixed gaggers, *k* (*Figs. 15, 18, and 19*), which carry the thin portion of sand between the body portion 1 and 2 and the flange marked 3 (*Fig. 12*). Before putting this box on, however, a layer of sand must be placed on that portion of the pattern which will be covered by the projecting irons, as it will be difficult to get it underneath after the box is in position. The flange 3 (*Fig. 12*) is now put on, and the sand packed well underneath it. The box is then filled with sand and rammed up, provision being made for a joint round the flange. This joint is required to enable the flange to be withdrawn.

Box part C is next put on, and after being rammed up the whole is turned over, the follow board 5 removed, the mould faced off, and made ready to receive part pattern No. 4.

The parting plate *f*, to carry the drawback E (*Figs. 12 and 15*), is prepared, and laid over the leg end of the pattern. A layer of sand is put on this plate, and three gaggers, *l* (*Figs. 14 and 15*), are placed on each side to carry the overhanging part of the joint. The part pattern No. 4 is then bedded to make an impression over the plate. It is then removed, and two nails, *p* (*Fig. 13*), are placed across to carry the portion of sand between the overflow and delivery pipes. The pattern is replaced, and the sand made level to the half of pattern No. 4, and parting sand sprinkled over, making ready for box part D. When this is placed in position, a gating plus is placed over the gate *h* (*Figs. 12 and 14*), already provided in box B.

A layer of sand is now placed in the cavity *r* (*Figs. 14 and 15*), to receive three gaggers, *n*, which are to carry the proud portion of sand at this place. When this box is filled and rammed, the box parts are taken asunder and the pattern parts withdrawn in the reverse order that they were put in.

On reference to *Figs. 12 and 14*, it will be seen that the metal is run in down a gate having two branches. After the pouring gate is completed, the mould is dusted with powdered plumbago, then skin-dried, and made ready to receive the cores. Whilst the pattern is being moulded the cores have been made and dried.

In making the cores, red sand, manure, and coal dust only are used, no special material being required. For the large core *d* (*Figs. 13, 14, 16 to 19*), owing to the complicated bends in it, one core-iron is bent and fitted to the box, and is then used as a pattern, and cast in brass. This enables a correctly shaped core-iron for each succeeding core to be made, so that no time is wasted in bending core-irons for each injector. For the small cores a special iron is bent each time a core is required. One half the core-box is filled with sand, and before being rammed tight, the core-iron is clay-washed and laid in the soft bed of sand. More sand is then put in and rammed lightly, and parted off to the level of the core-box. The other half is also rammed with sand and cleaned off to the joint. Each half is then clay-washed and a wax vent, *v* (*Figs. 13 to 19*), is laid right through; the box is then joined together and hammered with a mallet, after which the ends are rammed with sand to make them level. The core is then taken from the box and placed in the stove. All the cores are dealt with in a similar manner, except those that are straight and do not require wax vents, string vents, *w* (*Figs. 13 to 19*), being used instead. When the cores are dried they are taken from the stove, dressed off, subjected to a thick coat of blacking, and again dried, after which they are ready for the moulder. It is essential that the core-boxes for injectors should be made of strong and well-seasoned timber, so that they will retain their proper shape after being in use for a considerable time. The prints on the core-boxes should also be dead lengths to the prints on the patterns, so that the moulder will have no rubbing whatever to do when these cores are being fitted in the mould.

The cores are assembled in the following order:—

Box parts B and C are first fastened together. Core *a* is then placed in position, one stud, *s* (*Fig. 15*), being put under the overhanging portion of the ejector steam passage. Box part A is then put on

and another stud, *f* (*Fig. 18*), is inserted between this and the top of the same core, to keep it from lifting when the metal is being poured.

Core *b* comes next, and this is kept steady by having a long print on the bottom.

The overflow core *c* is then fixed, and over the leg of this is placed the drawback plate *f* (*Figs. 13 and 15*).

Owing to the construction of cores *d* and *e*, it is necessary to insert core *e* into core *d*, and lower both together into the mould. When this is done, a piece of string is inserted into the vent holes at the three ends of cores *a* and *d*: this string is withdrawn after the box part D has been secured in position, thus allowing free vent through the mould from the cores. A holding-down chaplet, *q* (*Fig. 13*), is placed over the arched portion of core *d*, and fastened into box part D, which is then put on and secured.

A runner box is prepared and placed over the gate, and this completes the moulding process.

It is important to reduce the number of cores to a minimum, and consequently the joints, thereby minimising the risk of flashes, and producing free passages for the flow of water.

Plate patterns are used in infinite variety. They include all sizes of nuts up to 2½ in., spindles, injector and ejector details, wheels, oil syphons, cylinder cocks, and a variety of plugs, etc.

Phosphor Bronze.

Mr. Arnold Philip's Paper on "Phosphor Bronze" to the Institute of Metals* has now become a standard reference, and the author will not be expected to proceed to lengthy detail here. The composition of the phosphor bronze used by the Lancashire and Yorkshire Railway Company is as follows:—

	Per cent.		Per cent.
Copper	86.0	To give by analysis Copper ..	89.5
Tin	10.0	Tin	10.0
15 per cent. phosphor copper ...	4.0	Phosphorus	0.5
	100.0		100.0

It is made entirely from clean picked scrap and new ingot tin, and phosphor copper. It is used for general repairs to heavy machinery, also for mill bearings, and wheels, and pinions, where great wear takes place.

This mixture has given general satisfaction in gearing at goods yards and docks, working in worm wheels, in conjunction with steel worms. It is chiefly moulded in dry sand, and presents little trouble in casting. It is practically free from slag, which fact is a result of the cleanliness of the materials used. It casts clean and is readily dressed.

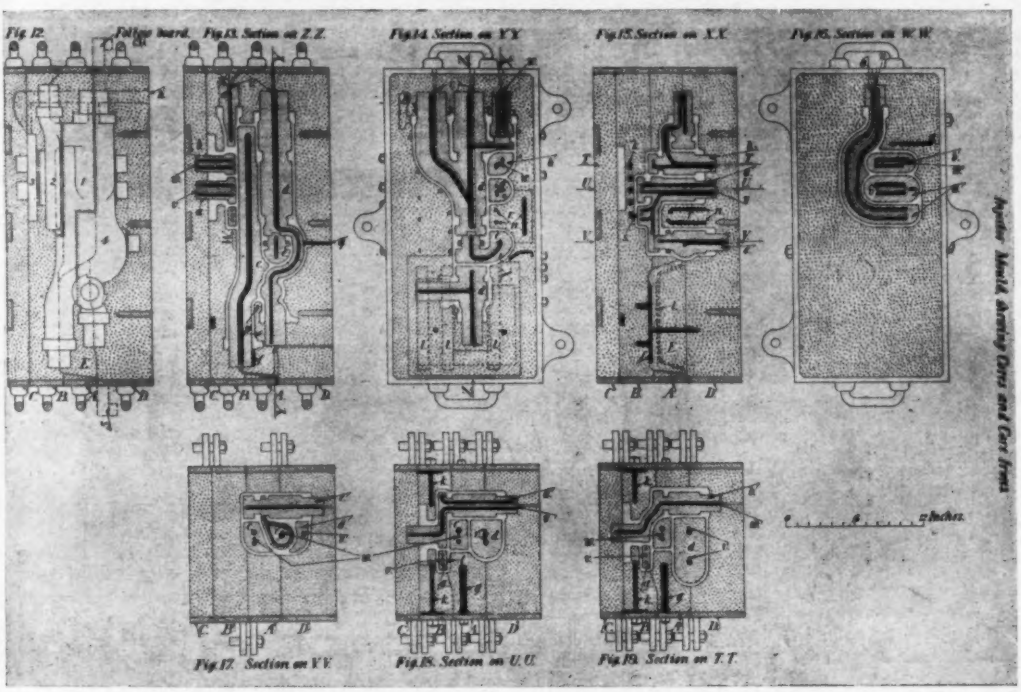


Fig 12.
Fig 13. Section on Z.Z.
Fig 14. Section on Y.Y
Fig 15. Section on X.X.
Fig 16. Section on W.W
Fig 17. Section on V.V.
Fig 18. Section on U.U.
Fig 19. Section on T.T.
Injector Mould, showing Cores and Core Irons

FIG. 4.—(*Figs. 12-19*) INJECTOR MOULD, CORES, CORE IRONS, ETC.

Other Mixtures in Use.

	Copper	Zinc.	Lead.	Tin.	
Yellow brass ...	67	30	3	—	For cab rings, name-plates, &c.
Brazing metal ...	84	16	—	—	Pipe flanges, collars, &c.
Telegraph metal	80	7.5	7.5	5	Small castings
	Aluminium	Copper	Zinc.	—	
Light aluminium alloys	95	5	—	—	For motor dust caps, grids, and some carriage fittings.
	85	—	15	—	

* "Journal of the Institute of Metals," No. I., vol. i., p. 161.

White Metal.

The chief precaution in mixing a white metal suitable for lining bearings, axle-boxes, and big end-brasses for locomotive connecting rods, is to avoid overheating of any of the component metals. Thus, in preparing alloy "C" a primary melt is made of equal parts of copper and tin, which is cast into chills and subsequently broken into pieces to be re-melted in the required amount together with the antimony, the remaining tin being added from time to time, with careful stirring. This method is preferable to the simpler one of melting the copper and antimony direct, and is found to result in cleaner metalled surfaces. The product is cast into heavy iron chill moulds for use as required in the metal shop.

coupling-rod bushes, cross-heads, and certain other parts requiring a stiffer alloy than type "B," with a basis of lead; that is to say, "B" withstands pressure well, but not the hammering brought about by reversals of motion. It has done good service in lining-up main axle boxes, radial wheel brasses, reversing shafts, etc.

The success of a bearing metal alloy depends more upon structure than absolute composition, the proper distribution of a number of the tin-antimony crystals in a softer matrix of tin or lead being essential. The alloy must run cool without any cutting of the axle journal, and the wear on this should be reduced to a minimum.

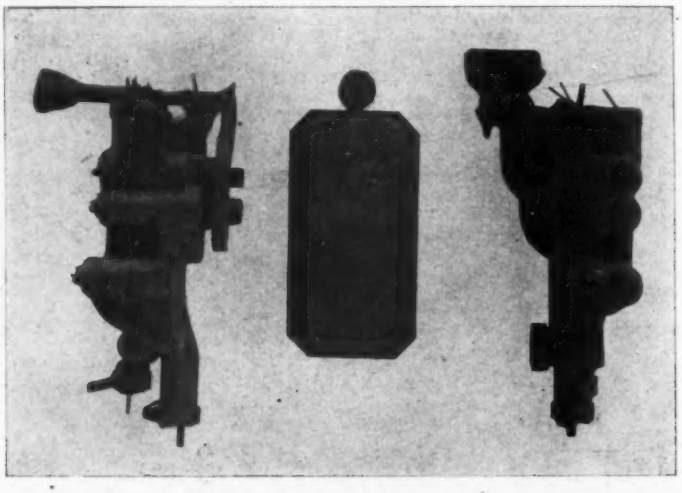


FIG. 5.—INJECTOR CASTINGS.

White Metals for Bearings.

Three types of white metal are used for lining bearings :—

	"A" Per cent.	"B" Per cent.	"C" Per cent.	"D" Per cent.	"E" Per cent.
Tin	82.0	11.5	80.0	54.0	85.0
Antimony	14.0	13.5	10.0	11.0	7.0
Copper	4.0	3.0	10.0	1.0	8.0
Lead	—	72.0	—	34.0	—
	100.0	100.0	100.0	100.0	100.0

"A" is used for high-class axle bearings on the pinion and commutator ends of motors on the electrical rolling stock running on the Lancashire and Yorkshire Railway between Liverpool, Southport, and Crossens. The motors have a speed of 780 revolutions per minute, at 50 miles per hour, developing 150 horse-power at the pinion. Under trying conditions of service, "A" was adopted after careful comparisons with solid gunmetal bearings and other alloys of tin and lead.

Table III. is a record of tests made on four types of bearing metals showing percentage hot bearings, broken collars, days in use, etc., in which the suitability of this metal is clearly seen. The solid brass was the Admiralty gunmetal mixture previously noted.

For locomotive work a harder variety, "C," of this metal, containing 10 per cent. copper and 10 per cent. antimony, is used in big end-brasses,

White-Metalling Axle-Boxes.

As an example of this process, a radial axle-box brass will be dealt with, as shown in Fig. 6. This consists of a cast-iron box, *a*, having three sides, and a heavy base; and a plate, *b*, resting on the base of, and secured to, the box by four links and cotters, *d* and *e*, to which is attached the cast-iron chill *c*. The combined plate and chill, *b* and *c*, having been removed, the brass *f* is placed in the

TABLE III.

Conditions.	Solid Brass.	"D" Metal.	"E" Metal.	"A" White Metal.
No. on test	39	39	35	58
No. taken off due to wear	16	9	17	16
No. taken off hot	6	—	3	3
No. taken off with broken collars	2	23	12	18
No. still running	11	1	3	21
Average life of worn bearings, days	236	193	263	241
Average life of hot bearings, days	186	—	141	257
Average life of bearings with broken collars, days	286	191	281	215
Average life of bearings still running, days	409	447	380	406
Average life of total bearings used, days	318	189	259	299
Per cent. of hot bearings to total	30·7	—	8·5	5·1

space formed by the three sides of the box; the plate and chill is secured in position as aforementioned, and the white metal poured in from the top, filling the space *g*. The same procedure is adopted when the brasses are metalled in the first instance. The old metal having been melted out of the box, the recesses are well cleaned and rasped with a coarse file. All dirt having been thoroughly removed, the box is placed on a coke fire and slowly heated. By the use of sal ammoniac and tin, a very

thin coating is produced for uniting with the white metal, which is then cast into the bearing. The metal (type "B") is cast at a temperature of 450 degrees C. from the open pan fire.

Other white-metal mixtures are:—

Lead.	Tin.	Antimony.	
92	—	8	For packing ball-joint water pipes
70	17	13	Metallic packings.

NON-FERROUS METALS IN RAILWAY CARRIAGE AND WAGON CONSTRUCTION.

Aluminium.

It is only in quite recent years, after a considerable reduction in price has been made, that the use of aluminium can be shown to be a commercial advantage in many branches of railway engineering and rolling stock, where it is slowly supplanting the use of other metals.

Mouldings and Facias and inside Furniture fittings for Steel Cars used on the Tube Railways.—The extended use of steel cars for tube and surface railways and the consequent increase in deadweight as compared with the older form of timber construction, has led to the adoption of various forms of aluminium mouldings, facias, etc., to compensate to some extent for the additional weight of the steel girders, angles, channels, etc., used in the designs.

Bearings for Carriage and Wagon Axle-boxes.—It is reported that the Northern Railway of France is substituting for the bronze bearings hitherto in use on rolling stock, bearings made of an alloy of 92 per cent. aluminium with 8 per cent. copper, and that certain bearings of this alloy have run 50,000 miles without showing any trace of wear, and owing to its relative lightness the cost has been considerably reduced. Experiments on the Lancashire and Yorkshire Railway do not yet confirm this satisfactory result, it being found that the material is hard and brittle, and considerable labour is involved in properly bedding the bearings to the journals, and preventing heating under normal running conditions.

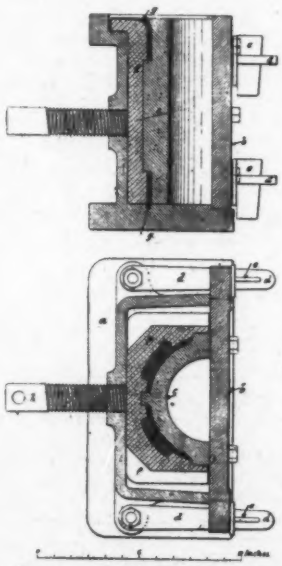


FIG. 6.—CHILL FOR METALLING RADIAL AXLE-BOXES.

White metals, for the lining of rolling stock bearings, are largely used, although the lining for a pulley-shaft bearing and that used for a railway vehicle will differ, owing to the variation in the load, method of lubrication, and conditions under which they are working.

Of the metals forming anti-friction alloys, it is unusual to find more than three in any particular mixture; a very common alloy used is that for the lining of carriage and wagon bearings, which consists of antimony 15 per cent., lead 70 per cent., and tin 15 per cent. It is common practice for the bearings, after being lined with about $\frac{3}{16}$-in. thickness of alloy, to be bored out in a machine and finished off by hand, but successful results have been made by casting a better finished surface from the mould, and bedding it direct on to the journal.

The following types of brass bearings are lined with $\frac{3}{16}$-in. white-metal alloy for railway bearings:—10, 12, 15, 20, and 30 ton wagons, and all bearings for carriage stock, and the same applies to private owners' wagons, with the exception of wagons of 8 and 10 tons capacity, which are specified in brass; the thickness of the white-metal lining in these vehicles varies from $\frac{3}{16}$ in. to $\frac{5}{16}$ in.

Brass.—Brass is used in car construction for such purposes as gas and electric fittings, parcel racks, hat and coat hooks, ash trays, hinges, outside door handles and commodes, and various other details for which it is particularly suitable.

Zinc.—Zinc is usefully employed in its sheet form for ventilators, roof coverings, and mouldings.

As a matter of convenience Table IV. gives in a concise form the composition of these alloys:—

TABLE IV.—*Alloys Mentioned in the Paper.*

Used for	Cu.	Sn.	Sb.	Zn.	Pb.	Fe.	P	13 per Cent. Pb. Cu.	Al.	Ni.
Scrap ingot metal	86·5	7·5	0·08	2·3	3·2	0·2	..	..	.	...
Slide valves	84·5	10	...	...	5	...	0·5	...	...	..
Gun-metal	88	10	...	2	...	..	..	...	..	..
Injector metal	84	8·5	...	5	2·5	...	..	...	...	..
Phosphor bronze to give	89·5	10	...	...	..	...	0·5	4	..	..
Yellow brass for cab rings, name-plates, &c.	67	...	...	30	3	.	.	..	...	..
Aluminium alloys for motor dust caps	5	...	...	...	...	..	..	..	95	..
Brazing metal	84	...	...	16	...	..	..	..	...	...
Telegraph metal	80	5	...	7·5	7·5			..	...	...
Aluminium alloys for some carriage fittings	15	...	..	..	...	..	..	...	85	...
White metal, "A"	4	82	14	...	..	...	..	...	..	...
White metal, "B"	3	11·5	13·5	...	72	...	..	..	...	...
White metal, "C"	10	80	10	...	..	...	...	...	...	..
White metal for packing ball joints	...	..	8	...	92	..	..	...	..	...
White metal for metallic packings	..	17	13	.	70	..	..	..	...	...
White metal for carriage and waggon bearings	..	15	15	.	70	...	..	...	..	...
Ordinary axle-box bearings	80	5	...	...	15	..	..	...	..	...
20-ton waggon bearings	64	5	...	...	30	..	..	...	..	1
Argozoil (ornamental fittings)	84	2	...	28	2	..	..	..	...	14
Solder (electric fittings)	...	94·5	..	...	5·5	...	...	...	...	...
Solder (Plumbers')	..	50	..	...	50	...	...	...	...	...
Solder (Tinsmiths')	...	60	...	..	40	...	...	...	...	...

A voluntary movement among the employees of the late Lord Airedale has resulted in a memorial of him being placed on the lawn of the Leeds Workpeople's Convalescent Home, Springfield, Horsforth. On the four sides of the pedestal is inscribed: "James, First Baron Airedale of Gledhow. Erected by the employees of Airedale Foundry, Monkbridge Iron and Steel Company, and Stanningley Ironworks, in memory of his kind and generous actions towards them." The unveiling ceremony was performed on October 7 by the present Lord Airedale, and representatives of the workpeople attended. The large company present included Mr. F. R. Spark, the Lord Mayor (Mr. William Middlebrook, M.P.), the Hon. R. D. Kitson, Mr. Sydney Kitson, Mr. C. F. Tetley, Mr. W. H. Clarke, and Mr. J. Eagleton (secretary to the late Lord Airedale).

Rotary Core Machine Difficulties.

These notes are intended to appeal to those who use small, straight cores (up to, say, 3 inch diameter or square), and who have either failed to secure satisfactory results from the rotary type of core-making machine or who are prejudiced against the machine. Many machines have been laid on one side as useless, and it is in order to assist those people who have had this unfortunate experience that the following hints are penned. Assuming that one realises the advantages of securing perfect cores (which leave holes that in many cases do not require any machining) at an exceedingly rapid rate, the troubles which are generally met with, and how they may be overcome may be considered.

The principal difficulty which users of these machines experience is that on attempting to make cores the sand jams in the die and either refuses to produce a core or makes a very hard and non-porous core. One source of this trouble is an obstruction in the die. When being used for the first time, or after a period of disuse, all dies should be well polished and any rust, grit or grease removed, so that they are perfectly smooth inside. It is obvious that if there is any resistance in the die, friction is bound to take place, and the secret of the rotary core machine is that by experimenting with various pitches of worms and lengths of die tubes, the amount of resistance to be overcome in order to produce cores of the correct density for the required purpose has been ascertained. These factors having been determined under favourable conditions it is, of course, essential that no departure or deviation should be made, as by the use of a rough die or tube.

Another and more serious cause of trouble is that of mixtures. The chemical composition or "nature" of sands is so varied that practically every sand requires mixing differently, and many users have failed to realise this fact. Consequently, when they have been unable to make cores with a stock of standard formula they have blamed the machine and discarded the method. There are now many hundreds of rotary core machines in this country, of various types, and probably there is not an entirely unsatisfactory machine in the whole lot. Of course, more modern models have been improved somewhat and enable better results to be obtained, but the principle on which they are made remains the same as in the case of the older machines. It is necessary, therefore, and well worth the while, to experiment with such sands as are available. With very few exceptions cores can be made on these machines from all kinds of sands.

Except in the case where flour is used it is preferable to use a combination of two different kinds of sands, but the question of the use of flour may be first considered. As a rule, flour is considered to be too costly to use in the making of cores. In many places, however, it is possible to procure "sweepings" from millers at as low a price as a shilling per ten-stone sack, and if this is possible and the cores are required for use with cast-iron, perfect results can be obtained economically by the use of this material in conjunction with a sharp or washed sand. One advantage in using flour or "sweepings" is that the cores are produced with remarkable ease, and consequently the wear on the worm is comparatively small. Of course, where cores are required for malleable iron, steel or brass the use of flour is not permissible, as the castings would "blow," but this point will arise later.

The following is a very serviceable flour mixture (provision will be made later for those who take exception to the use of linseed oil):—

32 parts sharp or parting sand
1 part flour or "sweepings"
1 part boiled linseed oil
Water to suit.

The above proportions are in bulk, not weight, and a vessel of some kind should be used for measuring both the solids and the liquid. The tempering is, of course, an important feature, but this is easily acquired by a little practice. The amount of water required will be found to vary according to the size of core needed, the smaller cores requiring more moisture than the larger ones.

When first starting the machine, the 1 inch die should be tried, as this is the easiest size of core to make, and after this has been satisfactorily produced, the operator should proceed in a downward direction, adding more water as it is found necessary on coming to the smaller cores. The larger dies can then be tried with a dry mixture, starting at the biggest size and continuing downwards as before. If the core breaks before it reaches the end of the tray, either the latter is not straight or level or the mixture is too dry. If the core swells or bursts, the mixture is too wet, and a smaller size of die and worm should be put in the machine. The more water used the harder the core, and if the latter is "mealy" when dried, insufficient moisture has been added to the sand.

Now as to the question of flourless mixtures. In this case a substitute must be found for the flour, which acts as the binder, in the mixture already given. Ordinary core gum may be used (about half the quantity given for flour being sufficient), or a sand containing alumina should be introduced. In the latter case the proportions given hereunder may be taken as a guide, but, as previously stated, it is here where it is necessary to experiment a little in order to secure the best results:—

24 parts loamy sand
8 parts sharp sand
1 part boiled linseed oil
Water to suit.

With regard to the first-mentioned item, sand of a similar nature to Mansfield sand gives very good results, and where washed sand (sharp sand) is not available, parting or burnt sand may be used. Cores made from a mixture of this kind do not always come out so readily as when sharp sand is used in conjunction with flour, and there is a little more wear in the worm; but very good results can be obtained, and the mixture is an economical one, which is also suitable for use with malleable iron, steel or brass.

It is interesting to watch the behaviour of metal in connection with cores of various compositions. To enable this to be done a hole should be made in the foundry floor and a core inserted in the centre of the hole. It will be observed that when the core contains flour the molten metal is somewhat restless or disturbed, whereas when a flourless mixture is used the metal is quite still. For well-known reasons linseed oil has now reached an exorbitant price, and by ex-

perimenting a little a substitute may readily be found. Various other kinds of oil, however, may be used. Common fish oil is cheap and works well with the machine, but the odour given off when under heat is sometimes objected to. Common lubricating and minerals oils are also suitable, and the writer knows of one firm using an oil for this purpose which costs only 4d. per gallon, and on one occasion he himself made some cores with a refuse axle-box oil. As a rule it will be found that when oils of this class are used a somewhat larger quantity is required than in the case of boiled linseed oil. The cores also do not come out so readily as with the more expensive mixtures, and under these conditions it is advisable to run the machine by belt.

Readers are strongly advised to bring out any machine which may have been condemned and give it another trial on the lines indicated, when they will be agreeably surprised by the results obtained. It is possible to make from 200 to 720 feet of core per hour on rotary core machines, and after users have become convinced of the capabilities of the machine they can generally effect considerable economy from the use of same. As the cores are so perfect and accurate, and in many cases render machining unnecessary, it is possible to use larger cores than is the case when made by hand. The advantages of this are obvious.

British Foundrymen's Association.

Lancashire Branch.

The opening meeting for the session of the Lancashire Branch of the British Foundrymen's Association took place at the Manchester Municipal School of Technology, on October 7, when Mr. F. PENLINGTON (Manchester) delivered his Presidential address. He said that under his two predecessors, who were gentlemen of experience, social influence and enthusiasm, the Lancashire Branch had been nursed from infancy to a vigorous youth, and its further development rested with the members. Their loyal support was especially required because of the innovations which it was proposed to introduce with the object of enlarging the membership, of bringing the Association more prominently before engineers and founders, and of increasing its utility, so that founders might take their proper place as a section of the engineering trade of equal, if not greater importance than any other. Primarily it was an educational association, and sought to impart to its members the scientific and theoretical knowledge acquired by years of research, but they had also to keep in mind the practical part of their business, which in the past had not received the attention it deserved.

Originally the employer was also a craftsman who worked alongside his men and under whose supervision the apprentice was trained, but with the commercial development of the industry it had passed under the control of companies who were more concerned with making profits than training craftsmen, and the management was put into the hands of foremen. To make a successful foreman or manager, several qualifications were necessary. He must be a good organiser, not only of methods of work, but also of men, knowing their characteristics and how to blend and combine them, so that the best might be obtained from each to the benefit of the whole. He must also have a good knowledge of cupola practice, and in connection with that there were several matters which had to be borne in mind. The iron could only be melted satisfactorily at one place in the cupola, *i.e.*, the melting zone, the location of which varied according to circumstances. Once this had been ascertained the bed charge must be regulated accordingly. To put in less coke than was necessary to reach that point would mean bad melting, resulting in dead or sluggish iron; to put in more coke than was necessary meant that there was a waste of fuel, resulting only in burning away the lining of the cupola. It was better to have small charges with less coke than large charges with more coke. The pieces of scrap should be broken up small, because then they melted and mixed more quickly. He also recommended that the metal be arranged in a circle and not thrust in indiscriminately. The waste gases generally played round the sides, and when the arrangement he suggested was adopted heat was utilised which would otherwise be wasted. The coke should be broken into pieces of uniform size, so as to avoid leaving cavities, and the blast pressure must be kept as uniform as possible. For this purpose it was desirable to have a pressure gauge. What the pressure should be depended upon varying conditions, but once it had been ascertained they should keep to it as closely as possible.

Commercial experience was also necessary. The foreman should know just what a piece of work was costing, and it was advisable to periodically compare his figures with the quotations obtained from outside. Most firms had a formula for finding the cost, and would supply it to a foreman who showed a desire to use it in the interests of the concern; but where this was not done the foreman ought to adopt a system of his own which would keep him informed as to the direction in which his costs were going, whether up or down.

After giving details as to how the costing should be done, the President expressed a hope that founders, and the engineering trade generally, would realise the value of the work the Lancashire Branch was doing, and that it would become the leading Branch of the British Foundrymen's Association. (Applause.)

MR. R. W. KENYON said they heard a great deal about the necessity of practical work, and he assented to it, but Mr. Penlington had demonstrated to them that it was equally necessary to have scientific knowledge. His insistence upon the importance of costing was also to the point. A neglect to attend to this accounted for several failures that he knew of, where founders were unable to find out what their castings were really costing. Probably they had no formula to assist them, and did not try to make one for themselves.

MR. MARKLAND said they must have a Paper devoted to the subject of costing alone. Apparently there was very little known about it, and it was very important. As regards cupola practice, his own experience bore out what the President said about the necessity of finding out what was the proper charge for the cupola. At one time they filled to a much greater height than was necessary, and he took off a riddleful of coke each day until the proper height was ascertained, and a considerable saving was thus effected.

MR. SHAW asked how long a cupola lining ought to last?

The PRESIDENT said he was at present using a cupola capable of melting 3 tons per hour, and turning out on an average 10 tons per day, and it was rebricked every two years at holiday time. He considered that was doing exceedingly well. He knew a firm which rebricked every six months, but that, he thought, was very bad. An average time for rebricking would be once in twelve or eighteen months.

In reply to other questions, the President gave further details as to costing.

A vote of thanks to the President concluded the proceedings.

The Mechanical Influence of Carbon on Alloys of Iron and Manganese.

By J. O. Arnold,* D.Met., and F. K. Knowles,† B.Met.

In the "Journal of the Iron and Steel Institute," 1910, No. I., p. 172, in their Paper on "The Chemical and Mechanical Relations of Iron, Manganese and Carbon," Arnold and Read stated that "the influence of the carbon is very considerable, but is by no means the dominating factor, which without doubt is the manganese."

The present Paper may be regarded as being written mainly to prove the truth of the foregoing enunciation. The authors have already described‡ the methods adopted for the preparation of the steels employed, in the "Journal of the Iron and Steel Institute," 1906, No. I., p. 108 *et seq.*

Chemical Compositions.

With reference to elements other than carbon and manganese, the sulphur contents ranged from 0.02 to 0.04 per cent.; the phosphorus from 0.02 to 0.07 per cent.; and the silicon range was from 0.06 to 0.21 per cent.

Two series of steels were made, in both of which the manganese ranged from about 1 to 20 per cent.

In one series, however, the carbon was about 0.85 per cent., whilst in the other it was kept under 0.1 per cent.

Heat Treatment of the Alloys.

What may be regarded almost as the extremes of physical condition were secured in both series of alloys by a rapid and by a very slow cooling of the 1-in. round bars, which were respectively quenched in a tank of cold water from 860 degrees C. (quenched or Q series), and cooled from a similar temperature to milk-warm over a period of about three days (annealed or A series).

Turning Properties.

The authors' laboratory engineer, Mr. J. Harrison, reports his observations at the lathe during the preparation of the mechanical test-pieces as follows:—

TABLE I.—*Annealed Series.*

Steel No.	Carbon per cent.	Manganese per cent.	Physical properties.
952A...	Under 0.1	1.10	Soft.
977A...	,,	3.13	Soft.
961A...	,,	4.10	Slightly tough.
957A...	,,	5.50	Slightly hard.
951A...	,,	10.50	Very hard and very tough.
956A...	,,	12.90	Hard and very tough.
967A...	,,	15.70	Moderately tough.
955A...	,,	19.85	Tough.

The word "tough" has reference to the capacity of the material to curl off in spirals from the nose of the turning tool.

TABLE II.—*Quenched Series.*

Steel No.	Carbon per cent.	Manganese per cent.	Physical properties.
952Q...	Under 0.1	1.10	Slightly tough.
977Q...	,,	3.13	Slightly hard and slightly tough
961Q...	,,	4.10	Moderately hard. Slightly tough
957Q..	,,	5.50	Hard and slightly tough.
951Q..	,,	10.50	Would not machine.
956Q...	,,	12.90	,, ,, ,,
967Q .	,,	15.70	Slightly hard. Moderately tough.
955Q...	,,	19.85	Slightly hard. Very tough.

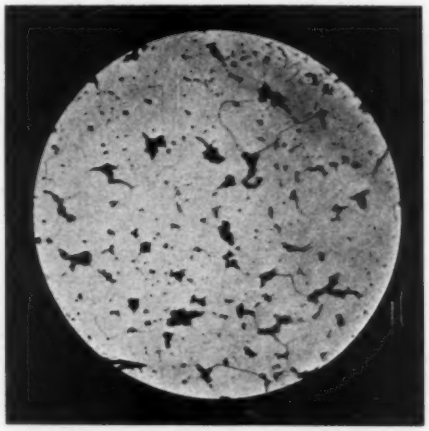


FIG. 1.—STEEL NO. 952A. CARBON UNDER 0.1 PER CENT.; MANGANESE, 1.10 PER CENT. MAGNIFIED 460 DIAMETERS. DIRECT LIGHT.

The behaviour in the lathe of the carburised series in their annealed condition was as shown in Table III.

TABLE III.—*Carburised Annealed Series.*

Steel No.	Carbon per cent.	Manganese per cent.	Physical properties.
990A...	0.85	1.16	Slightly tough.
998A...	0.84	3.10	Moderately tough.
999A...	0.87	4.98	Tough.
1085A...	0.95	10.07	Very hard and very tough.
1035A...	0 82	15 11	Hard and very tough.
1084A...	0.93	19.59	Slightly hard and very tough.

The above carburised series in a quenched condition are reported as "non-machinable" by the highest quality of Sheffield high-speed turning-tool steel.

Static Mechanical Tests.

The comparative tensile tests of carburised and nearly carbonless alloys of iron and manganese are

* Professor of Metallurgy in the University of Sheffield.
† Lecturer of Metallurgy in the University of Sheffield.
‡ *Ibid.* May 11, 1906.

embodied in Table IV., the steels being in their highly annealed state.

TABLE IV.

All test-pieces 2 inches parallel by 0.564 inch diameter.

Steel No.	Carbon per cent.	Manganese per cent.	Yield-point. Tons per sq. inch.	Maximum stress. Tons per sq. inch.	Elongation per cent. on 2 inches.	Reduction of area per cent.
990 A...	0.85	1.16	25.76	52.76	10.5	11.7
952 A ..	Under 0.1	1.10	19.04	24.48	43.5	79.7
996 A...	0.88	3.10	39.48	59.64	5.0	5.2
977 A...	Under 0.1	3.13	34.56	41.42	25 0	63.2
961 A...	,, ,,	4.10	20.56	53.48	25.5	42.4
999 A...	0.87	4.98	33.96	54 64	2.0	2.0
957 A...	Under 0.1	5.50	38.68	65.96	28.5	38.1
1085 A...	0.95	10.07	30.12	42.22	1.0	1.4
951 A...	Under 0.1	10.50	30.80	57.88	1.0	0
956 A...	,, ,,	12 90	19.80	56 12	6.5	4.6
1065 A...	0 82	15 11	28.00	49.88	9.5	9.7
697 A...	Under 0.1	15.70	37.80	63.72	17.5	20.6
1084 A...	0.93	19.59	24.68	52.16	23.5	19.5
*955 A...	Under 0.1	19.85	22.32	55.04	30.0	33.5

* The mechanical properties of a 30 per cent. manganese alloy may be found in Arnold's Paper on "The Uniform Nomenclature of Steel," *Journal of the Iron and Steel Institute*, 1910, No. 1, p. 190.

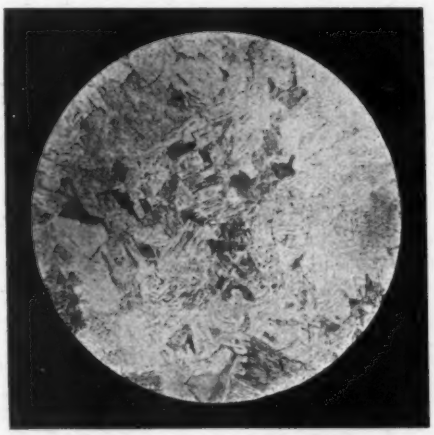


FIG. 2.—STEEL NO. 961A. CARBON UNDER 0.1 PER CENT.; MANGANESE, 4.1 PER CENT. MAGNIFIED 460 DIAMETERS. DIRECT LIGHT.

Dynamic Stress-Strain Tests.

The alternating tests carried out under standard conditions on the Arnold machine registered the results recorded in Table V.

The figures registered in alternation by a quenched nearly carbonless series are embodied in Table VI. The corresponding carburised series were not capable of being turned.

TABLE VI.—*Alternating Stress Tests on Quenched Alloys.*

Note.—The 10 to 13 per cent. manganese alloys would not machine.

Steel No.	Carbon per cent.	Manganese per cent.	Alternations endured.		
			1st Test.	2nd Test.	Mean.
952 Q ...	Under 0.1	1.10	248	276	262
961 Q ...	,, ,,	4.10	140	136	138
957 Q ...	,, ,,	5.50	30	22	26
967 Q ...	,, ,,	15.70	232	188	210
955 Q ..	,, ,,	19.85	208	206	207

Micrographic Features of Four Typical nearly Carbonless Alloys.

Micrograph, Fig. 1.—Manganese, 1.1 per cent. This

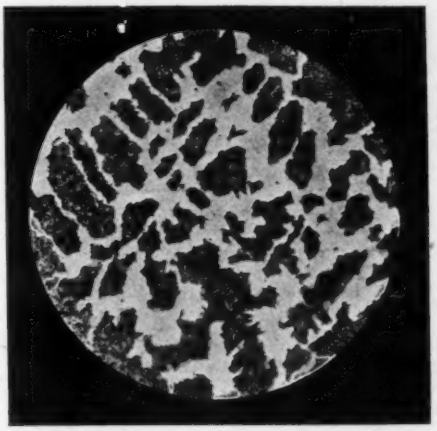


FIG. 3.—STEEL NO. 956A. CARBON UNDER 0.1 PER CENT.; MANGANESE, 12.9 PER CENT. MAGNIFIED 460 DIAMETERS. DIRECT LIGHT.

TABLE V.—*Behaviour in Alternation of the Annealed Serie*

Steel No.	Carbon per cent.	Manganese per cent.	Alternations endured.		
			1st Test.	2nd Test.	Mean.
990 A ...	0.85	1.16	160	162	161
952 A ...	Under 0.1	1.10	344	356	350
996 A ..	0.88	3.10	72	106	89
977 A ...	Under 0.1	3.13	186	182	184
961 A ...	Under 0.1	4.10	210	240	225
999 A ...	0.87	4.98	28	28	28
957 A ...	Under 0.1	5.50	192	222	207
1085 A ..	0.95	10.07	8	8	8
951 A ...	Under 0.1	10.50	6	6	6
956 A ...	Under 0.1	12.9	52	36	44
1065 A ..	0.82	15.11	214	238	241
967 A ...	Under 0.1	15 70	274	306	290
1084 A ...	0.93	19 59	226	272	249
955 A ...	Under 0.1	19.85	216	214	212

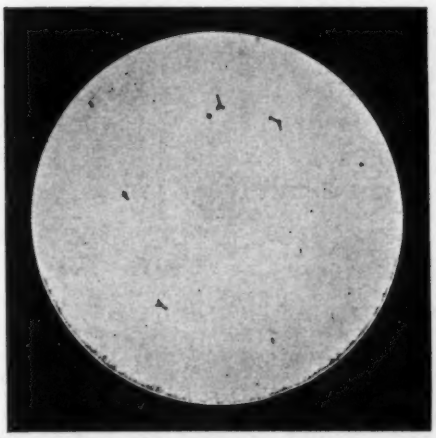


FIG. 4.—STEEL NO. 955A. CARBON UNDER 0.1 PER CENT.; MANGANESE, 19.85 PER CENT. MAGNIFIED 460 DIAMETERS. DIRECT LIGHT.

consists of allotrimorphic crystals of manganiferous ferrite with dark etching troostitic areas containing the double carbide of iron and manganese in an emulsified condition. The segregation of this first variety of manganiferous pearlite is obviously incomplete.

Micrograph, Fig. 2.—Manganese, 4.1 per cent. This section exhibits a martensitic structure often well defined.

Micrograph Fig. 3.—Manganese, 12.9 per cent. This micrograph (visually) speaks for itself. The authors are unable to offer any decisive explanation of the curious etching effects exhibited.

Micrograph, Fig. 4.—Manganese, 19.85 per cent. This section exhibits the apparently non-crystalline and soft alloy, having the colour of pale brass, which is typical of iron containing, say, from 15 to 35 per cent. of manganese. The softness of this type of alloy increases with the manganese within the limits named.

The authors, in conclusion, tender their thanks to their colleague, Mr. J. Wreaks, B.Met., for his beautiful and exact reproductions of the four micro-sections chosen to illustrate the Paper, and also to their melter, Mr. Stacey, for his skill in carrying out the difficult practical operations necessary to produce almost carbonless alloys of iron and manganese.

British Foundrymen's Association.

The Session's Arrangements.

A meeting of the General Council of the British Foundrymen's Association was held at the Midland Hotel, Birmingham, on Saturday, October 7. Mr. F. J. Cook presided, in the absence of Mr. Percy Longmuir, President, who was on the Continent.

All the programmes of Papers, etc., for the various Branches and the visits arranged were submitted and entirely approved. It is considered that the scheme for lectures in the various districts is much the best yet laid before the Council. Twelve new members were elected, bringing the total membership to about 700. It was arranged that the next meeting of the Council should take place at Carlisle, early in November, on a date to be decided. Arrangements were made for Mr. R. Buchanan to attend the opening of a new Branch at Halifax on October 13.

The following gentlemen were appointed as Literary Committee for the ensuing year:—Messrs. P. Longmuir (President), R. Buchanan, F. J. Cook, H. Pilkington, and S. A. Gimson. The general scheme of lectures and Papers for the various districts considered and approved by the meeting was as follows:—

Papers for the Coming Session.

Birmingham.—October 28, Presidential address, by H. L. Reason, Birmingham. November 25, "Fans for Cupolas," by E. L. Joselin, Birmingham. December 9, General discussion. January 27, 1912, "Some Facts as to the Action of Vanadium on Cast Iron," by J. Kent Smith, Liverpool. February 24, "The Microscopic Structure of Brass and Bronze," by O. F. Hudson, M.Sc., A.R.C.Sc., Birmingham. March 23, "Cast Iron, with a few words upon the changes taking place during heat treatment," by W. H. Hatfield, B.Met., Sheffield. April 27, "Melting Iron in the Cupola and Cupola Practice," by H. Pemberton, Derby. May 25, "The Production of Iron and its Alloys in the Electric Furnace," by J. H. Stansbie, B.Sc., F.I.C., Birmingham. Meetings will be held at the Technical School, Suffolk Street, Birmingham, at 7 p.m.

Lancashire.—October 7, Presidential address, by F. Penlington, Manchester. November 4, "Pattern-making to Modern Requirements," by T. R. Schofield, Manchester. December 2, "The Growth of Cast Irons after Repeated Heatings," by Prof. H. C. H. Carpenter, M.A., Ph.D., University, Manchester. January 13, 1912, Fourth annual dinner. February 3, "Pellets and Segregation in Iron Castings," by E. L. Rhead, F.I.C., M.Sc. Tech., Manchester School of Technology. March 2, Open discussion of foundry problems by the members. April 2, "Moulding a Gas-Engine Bed," by J. G. Robinson, Halifax. May 4, Election of officers and discussion by the members. Meetings will be held at the Municipal School of Technology, Manchester, at 4 p.m.

Sheffield.—October 24, "Art as Expressed in Castings," by W. F. Bagnall, Sheffield. November 21, "Inexpensive Pyrometers," by C. E. Foster, Letchworth. December 12, "Testing of Moulding Sand," by R. Mather, Woolwich, January 23, 1912, Annual Meeting. February 20, "The Growth of Cast Iron," by Prof. Carpenter, M.A., Ph.D., Manchester. March 19, "Mechanical Core Making," by H. S. Green, London. April 16, "The 'Stock' Converter Process," by Mr. Stock, Darlington.

London.—November 10, "Physical Properties of Cast Iron," by F. J. Cook, Birmingham. December 8, "Solidification of an Iron Casting in the Mould," by Prof. T. Turner, M.Sc., Assoc.R.S.M., F.I.C., Birmingham. December 9, Dinner at the Holborn Restaurant, W.C. January 12, 1912, "Growth of Cast Iron," by Prof. Carpenter, M.A., Ph.D., Manchester. February 9, "Brasses" (Author's name given later). March 8, Lecture by Harry Brearley. April 12, "The Application of the Microscope in the Foundry," by G. Hailstone, Birmingham.

Scottish Branch.—November 11, Presidential address by J. King, Glasgow, and Paper on "Warping in Castings," by R. R. McGowan. December 9, "Foundry Metallography," by J. S. G. Primrose, A.G.T.C., A.I.M.M. January 13, 1912, Problem night; open meeting. February 10, "Plasticity of Metals," by Prof. A. Campion, F.I.C., F.C.S. March 9, "Light Castings," by M. Riddell, and "Semi-Steel," by J. A. Ewen. April 13, Annual general meeting. Meetings will be held at the Technical College, George Street, Glasgow, at 4 p.m.

Welding Cast Iron with the Oxy-Acetylene Blow-Pipe.

From a pamphlet by the Acetylene Illuminating Company, Limited, we take the following:—

For welding cast iron with the oxy-acetylene blow-pipe, the fracture must first be grooved out to a V-shape, or in case of a new piece being inserted, all butting edges must be chamferred to ensure the weld penetrating right through the metal. After grooving, the casting must be heated to a dull red heat in a muffle furnace or over a coke fire. When hot draw the casting out of the furnace to weld. Follow the usual practice in welding, but use special ferro-silicon rod as the filling-in metal, and borax as a flux. A flux is necessary when welding cast iron. If the operation is a long one, it is necessary to re-heat the casting before completion. It will be found necessary to rub the rod well into the fracture during the welding to make a good weld and eliminate blow-holes. When the welding is completed, replace the casting in the furnace and heat to a dull red, then allow the casting to cool down very slowly, either by closing up the furnace, or burying the casting in dry sand.

A New Moulding Process for Hollow Castings.*

In making hollow castings by the ordinary processes, the preparation of cores is an essential feature, and is a source of considerable trouble and expense, not only as regards the making of the cores themselves, but also in arranging and securing them in the moulds. In particular, the production of ingot moulds by the usual method (ramming the mould to the external shape of the ingot mould in moulding boxes, inserting the core and spindle after removal of the pattern, driving a gate down to the bottom of the mould, and in some cases carrying the risers up from the bottom as well) is attended by a number of defects, such as large consumption of moulding sand (most of which can only be used once owing to the high temperature), heavy cost of preparing the

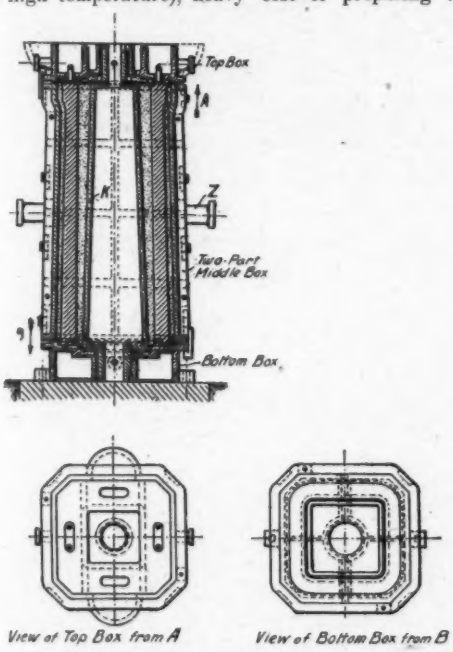


FIG. 1.—TWO-PART KURZE MOULD, WITH TAPERING HOLLOW CORE AND CORE FACING.

sand, considerable outlay on labour in ramming the sand moulds, cost of drying the cores in an upright position, the trouble and expense in getting the cores out of the finished castings, labour and wear and tear of tools in removing fins from the castings.

These drawbacks are obviated, or at any rate lessened, by the process introduced by W. Kurze, Neustadt (Hanover), which has been in use at the inventor's own foundry for some time, and is being adopted by others. Briefly, the advantages claimed for the new system comprise: abolition of patterns and ramming; large saving of sand (up to 80 per cent.) and moulders' wages (100 per cent.); uniform thickness of metal in the ingot moulds; increased working capacity of moulds; saving of about 66 per cent. of the usual cost of drying; easy removability of the cores, which drop to pieces on the spindles being drawn out; smoothness of castings inside and out, so that the cost of fettling is greatly reduced.

Fig. 1 shows the two-part mould box used in the Kurze process, with tapering hollow core. In the centre of the upper longitudinal section is the two-part middle box, with the lifting and carrying

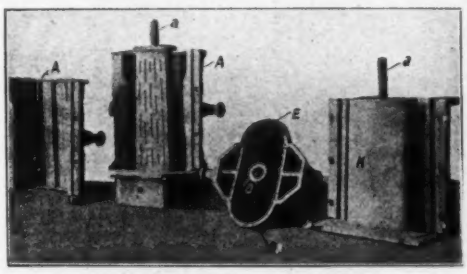


FIG. 2.—DETAILS OF MOULD WITH CORE.

trunnions, *Z*, the top and bottom boxes being also shown. The bottom box is preferably bolted to the floor by means of the lugs shown on the plan view; whilst the top box (seen from below in the plan), contains the troughed mouths of the gate and riser (at the sides), the central annular recess for the core spindle, and the devices for casting two wrought-iron rings into the upper end of the ingot mould. The core spindle *K*, which is fixed in the top and bottom boxes by the aid of journals, is coated externally with a layer of moulding sand, only about ½-1½ in. thick.

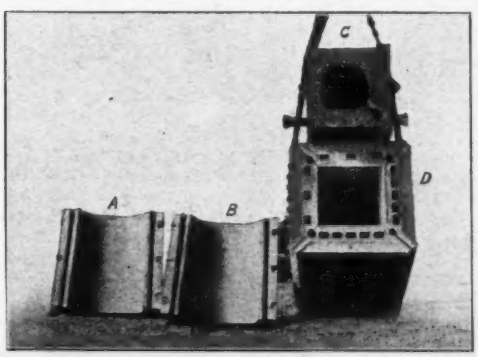


FIG. 3.—TWO HALVES OF MIDDLE BOX (A & B); A NEW FOUR-PART MIDDLE BOX (D); AND AN OLD PATTERN OF MIDDLE BOX (C).

A in Fig. 2 represents the interior of the middle box with the core in place in the bottom box, and with core-spindle, *a*, to fit in the top box; *B* a view of the top box from above, showing the pouring gate *E* and riser *S*; and finally, on the right of the drawing, is the finished core with its coating of sand, together with one half of the middle box. The moulding material is spread in the two halves of the middle box by means of a strickle, the thickness

* By A. Nachtweh, in "Giesserei Zeitung."

of the layer being controlled by two small gauge strips, cast or bolted on to the middle box.

A and *B* in Fig. 3 show the two completed halves of a middle box viewed from inside, whilst *D*, is a four-part box showing the necessary vents for the escape of the gases, and *C* is a mould box of the old

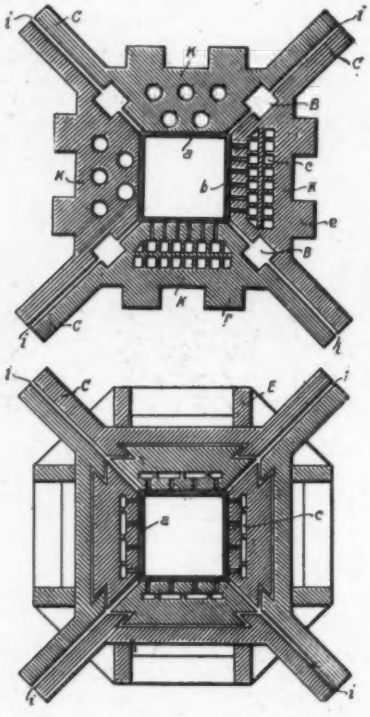


FIG. 4.—SECTION THROUGH TWO FOUR-PART MIDDLE BOXES.

type, in which can be seen the imperfectly centred cavity for the ingot mould and the holes for the gate and riser, both of which reach down to the bottom. An improved form of middle box is illustrated in Fig. 4, which is a sectional view through two 4-part boxes, the upper drawing showing two different arrangements of gas vents, together with the stiffening ribs, *c*, and the corner flanges *C*, by which the parts are secured together. A thin layer *a* of the moulding material is spread inside the box; and small pas-

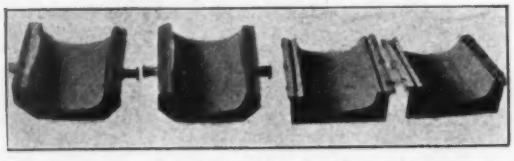


FIG. 5.—TWO TWO-PART MIDDLE BOXES AFTER FIVE POURINGS.

sages *b* lead from this layer into the gas vents *c* The lower sectional view shows how special lining walls can be inserted into the outer shell of the box by means of dovetailed guides.

Fig. 5 shows four halves of middle boxes after being used for casting five times. Each time, after use, the mould is examined, repaired and, if necessary, recoated with a very thin layer of moulding sand, dried and blacked; it can then be used over again repeatedly. Cases are reported from practical working with these moulds, where they have been used for 20 to 30 pourings without recoating with sand, except for slight patching

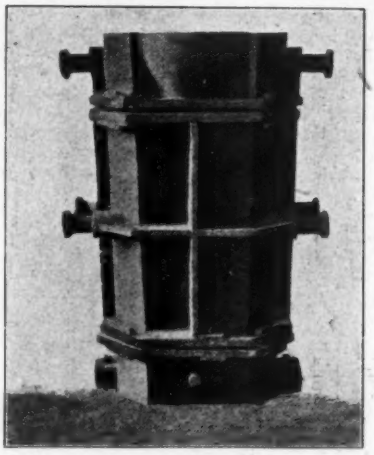


FIG. 6.—EXTERNAL APPEARANCE OF MIDDLE BOX FOR A 2½-TON INGOT

up here and there. The external appearance of a completely assembled mould box, ready for the casting of a 2½-ton ingot mould, is shown in Fig. 6.

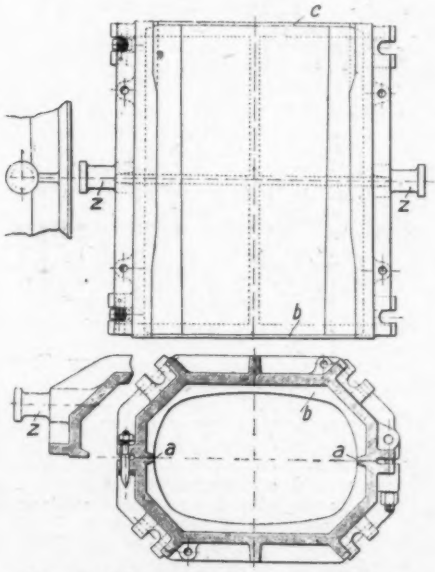


FIG. 7.—MIDDLE BOX FOR SLAB MOULD.

Fig. 7 gives a view of the middle box of a slab mould. The upper part of the drawing shows one half of the box, with the gauge fillets, *b* and *c*, controlling the thickness of the sand facing; the bottom drawing is a plan of the two-part box. Means are provided for coating the joints, *a*, with sand, so that all parts of the hot metal will be in contact with sand, and the casting will not require

working. Fig. 8 shows cross sections through a long box for casting four ingot moulds at a time; the lower half of the drawing represents a section through a box for casting two slab moulds together.

Turning now to the preparation of the cores, there

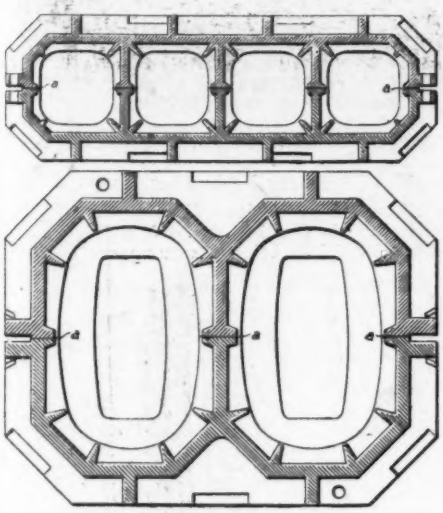


FIG. 8.—SECTION THROUGH A FOUR-INGOT BOX (TOP), AND A TWO-SLAB BOX (BOTTOM).

are three methods which can be followed for this purpose. Fig. 9 represents a simple box for coating a hollow core with moulding sand. The core spindle is slotted, and is fitted at top and bottom with bored-out wooden gudgeons, *a* and *b*, for centreing the spindle in the top and bottom boxes. The spindle

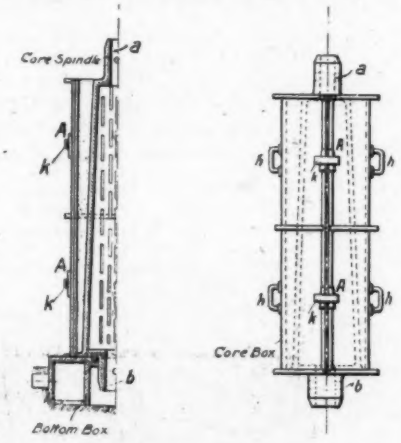


FIG. 9.—MOULD FOR RAMMING A CORE-FACING.

is wound with ropes of straw or wood-wool and inserted in the core box, the intervening space being then filled with rammed sand. Rapid detachment of the two halves of the box (which are fitted with handles, *h*) is facilitated by fastening them together by means of simple cast-steel clamps, *k*, which slip over dovetail flanges on the two halves of the box, as shown in detail in Fig. 10 on a larger scale. The winding of the core with ropes is performed in the vertical machine shown in Fig. 11, driven by a belt and the cones R_1 R_2

A second method of preparing the cores is illustrated

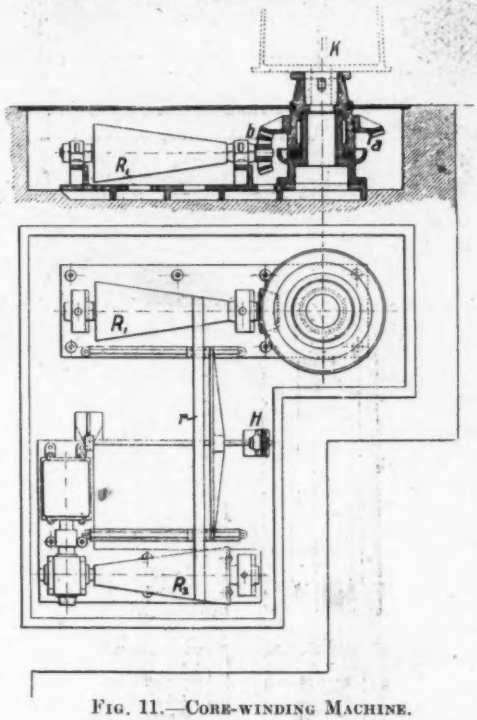


FIG. 11.—CORE-WINDING MACHINE.

in Fig. 12. The hollow core, *A*, provided with the necessary vents, *l* and *m*, is placed in a box, *K*, pro-

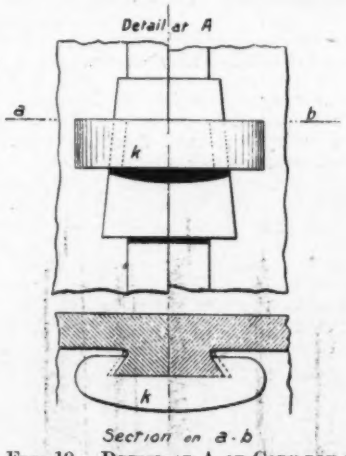


FIG. 10.—DETAIL AT A OF CORE-BOX IN FIG. 9.

vided with ribs, *B*. To guide the straight-edge in levelling the sand facing, a shaped fillet, *R*, is fixed on the right-hand side, by means of small dowels fitting into the holes, *i*; whilst on the left-hand side, a projecting edge, *e*, serves the same purpose. The damp facing of sand is sleeked with a straight-edge held parallel to the axis of the core spindle. The hollow core, with vent holes, is shown in Fig. 13, laid in its box, ready for coating with sand.

C

Figs. 14 and 15 show longitudinal and cross sections of different patterns of divided cores, which can be prepared in ordinary sand boxes. The cores are in

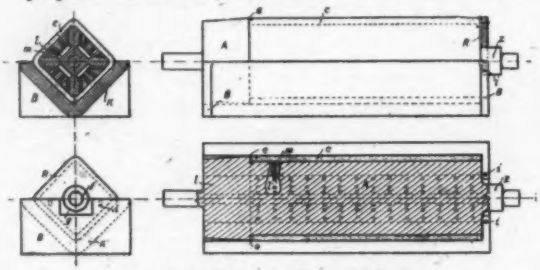


FIG. 12.—BOX FOR FACING CORES.

either three or four parts, held together by simple clamps, *a*, or (Fig. 15) by means of a spindle, *S*, in

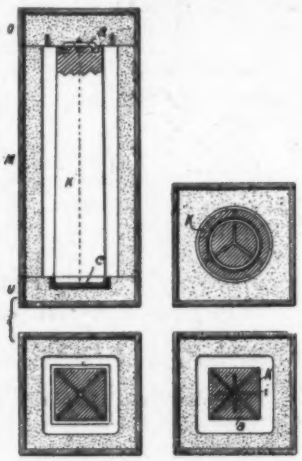


FIG. 14.—LONGITUDINAL AND CROSS-SECTION OF MOULD BOXES WITH DIVIDED CORES.

the shape of a cross, on which the four parts, *K*, of the mould are secured by dovetail guides. When faced with a thin layer of sand these cores are in-

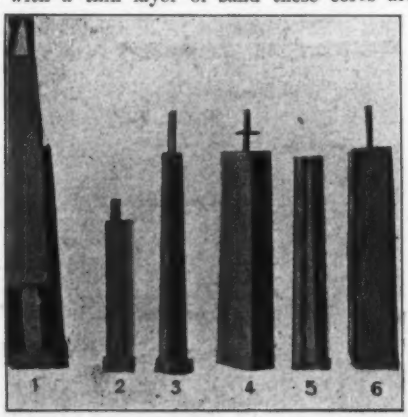


FIG. 16.—DIFFERENT CORES IN COURSE OF CONSTRUCTION.

serted into the cavity of the ingot-mould mould. After casting, the spindle, *S*, is knocked out with the hammer, whereupon the walls of the core also drop out, thus allowing the metal to contract. The core

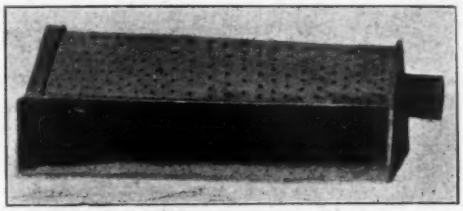


FIG. 13.—CORE WITH VENT-HOLES, LYING IN BOX.

walls, slipped on to the dovetail guides of the spindle, are illustrated in Fig. 16. No. 1 is a four-part core, one side of which is being drawn up out of position

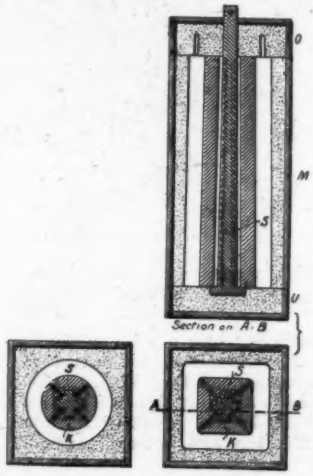


FIG. 15.—LONGITUDINAL AND CROSS-SECTION OF MOULD BOXES WITH DIVIDED CORES.

by the hoisting tackle. Nos. 2 and 3 are two forms of central spindle with the dovetail guides. No. 4

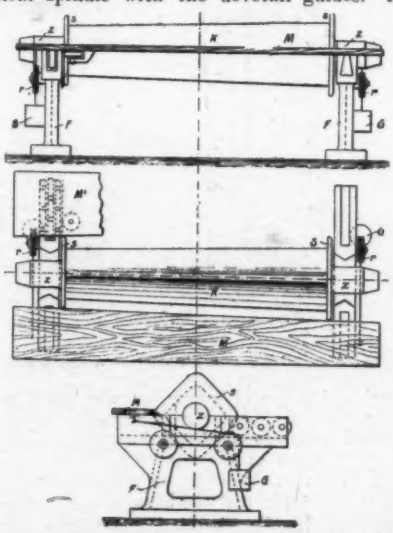


FIG. 17.—DIAGRAM OF KURZE CORE-MAKING MACHINE.

is an assembled core body; No. 5 a spindle with only two walls in position; and No. 6 a finished core.

The latest method of making cores (by the same inventor) is in a machine (Figs. 17 to 20) enabling loose pulley through pinion gearing, and a simple coupling, *M*. Fig. 19 shows the winding of the core-spindle with straw rope, and Fig. 20 the finished core, whilst Fig. 21 gives a finished core for a slab mould.

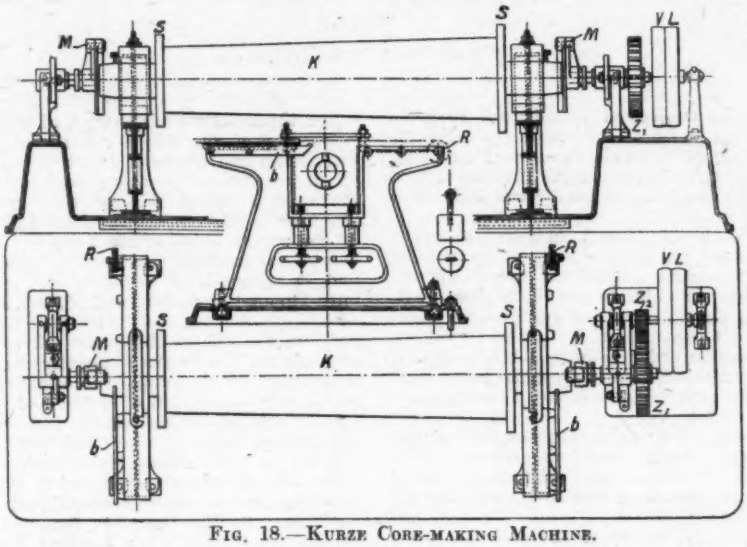


FIG. 18.—KURZE CORE-MAKING MACHINE.

different shapes of core to be turned out. The lower portion of the diagram, Fig. 17, shows how a core spindle, *K*, mounted on a pair of trestle frames, can be faced with sand by means of a modelling

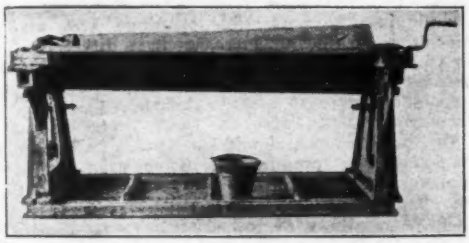


FIG. 19.—CORE-MAKING MACHINE WITH FINISHED CORE.

board, *M*, and two gauges, *s*. The lateral view shows how the modelling board is kept pressed against the

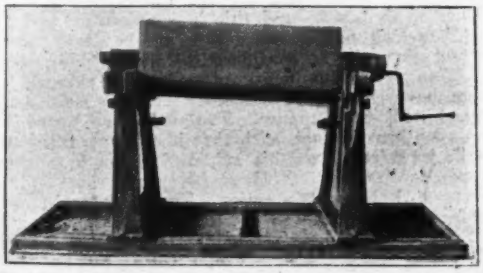


FIG. 20.—CORE-MAKING MACHINE WITH FINISHED CORE FOR SLAB MOULD.

ganges, *s*, by weights, *G*, suspended from ropes passing over pulley, *r*. Fig. 18 is a sectional view of a Kurze core-making machine, driven by a fast and

Electrochemical and Electrometallurgical Developments in Canada.

In a Paper before the American Electrochemical Society, read at their recent general meeting, Dr. S. Dushman, of the University of Toronto, gave a review of the electrochemical plants at present in operation throughout the Dominion of Canada. Amongst the principal ones are :—

The Trail, B.C., electrolytic lead refining plant (Betts process) of the Consolidated Mining and Smelting Company.

The Lake Superior Power Company, who make ferro-silicon in a Héroult furnace.

Electro Metals Company. Welland (ferro-silicon).

The American Cyanamide Company's 10,000-ton plant at Niagara Falls, Ont.

The Norton Company's plant at Chippewa for the manufacture of crystolon—a trade name for carborundum or silicon carbide.

The International Acheson Graphite Company, Niagara Falls, Canada (output in 1909 was 513,436 lbs. of artificial graphite).

The Northern Aluminium Company, Shawinigan Falls (capacity of 25 tons of aluminium per day, by the Hall process).

The Electro Reduction Company, Buckingham (phosphorus and ferro-phosphorus from apatite).

As to water powers in Canada, the total amount of power already developed and in process of development in British Columbia is 75,000 h.p. The numerous powers off the coast would aggregate another 50,000 h.p. In Ontario the sources of water power are almost innumerable. The Ottawa River alone would be capable of supplying over 300,000 h.p., while the numerous falls on the Gatineau could supply over 200,000 h.p. In New Brunswick only the St. John river has been exploited. The Grand Forks Power Company is building a plant at that place to develop 80,000 h.p.

Oil-Fired Open-Hearth Furnaces for Small Castings.

By Walter MacGregor.

In discussing the subject of open-hearth furnaces for the production of steel for small castings, the author will confine his remarks to oil-fuel furnaces, as operating with this fuel when the furnace is properly designed, the melter will have fewer difficulties to contend with.

It is well understood among engineers that the design of a furnace, to get the best efficiency from the fuel, depends entirely upon the nature of the fuel to be burned. In order to get the highest heat, the furnace body should be of such proportions as to burn the necessary amount of fuel in the smallest possible space, and in order to burn a large amount of combustible in a small space a short flame is necessary. The factors governing the short flame, according to fuel experts are :—

(1) A pure carbon fuel; (2) initial heating of the air which furnishes the oxygen for combustion; (3) intimate mixture of the oxygen with the fuel or diffusion; (4) large surface of the fuel presented for impact of this oxygen.

The first factor, the nature of the fuel, has been decided upon, the fuel oil with a probable analysis as follows :—

C.—83.26 per cent.
H.—12.41 per cent.
S.— 0.50 per cent.
O.— 3.83 per cent.
} With a specific gravity at 60 F. of .926.

The heat value of this fuel, according to Du Long's formulæ, would be 19,481 B.T.U. per lb. From this analysis we can easily compute the quantity of air required for combustion and the products of combustion for any amount of fuel burned.

As a representative size of the small open-hearth furnace, we will choose a 5-ton furnace, to melt and reduce 5 tons of metal; and from the time of charging the heat till the time of charging the following heat we will assume as four hours, and as the oil consumed varies so much in different furnaces, we will assume as an average fuel consumption, forty-eight gallons of oil per ton of steel melted in this time, or one gallon per minute.

Considering twelve pounds of air required for burning one pound of carbon, and thirty-four and seventy-eight hundredths pounds of air required for burning one pound of hydrogen, the analysis of the fuel gives :—

9.9912 lbs. of air required to burn the total carbon in fuel.
4.2161 " " " " " " " hydrogen in fuel.

14.2073
.16 correction of amount for oxygen in fuel.

14.0473 lbs. air required for complete combustion of 1 lb. of liquid fuel.

With fuel oil of 7.72 lbs. per gallon, 14.047 × 7.72 = 108.37 lbs air are required per gallon of oil.

With air at 13.14 cubic feet per lb., 108.37 × 13.14 = 1424.11 cubic feet air are required to burn one gallon of fuel oil.

Hence, to burn one gallon, theoretically 1,424 cubic feet of air per minute must be admitted into the furnace. To this must be added the amount of air required in reducing the carbon and silicon in the metal.

Ten thousand pounds charge, of which 12½ per cent. is pig-iron of about 2½ per cent. carbon and the rest steel scrap and billets of about 0.30 per cent. carbon, all to be reduced to about 0.18 carbon at the time of tapping. From this the total carbon content of the bath is 56.5 pounds, to be reduced to 18 pounds of carbon, or 56.5—18=38.5 pounds of carbon to be burned out in about two hours of reducing the charge, and, as before, 157.6 cubic feet of air are required to burn 1 pound of carbon, and 157.6 × 38.5=6,070 cubic feet of air are required in two hours, or 50 cubic feet per minute. All of this passes off with the products of combustion. In the same way can be determined the amount of air required in eliminating the silicon, which will run about 42 cubic feet per minute. A certain amount of oxygen is also taken up by the manganese, but this is so small as to be negligible.

With the total theoretical amount of air required, 1,424 + 50 + 42 = 1,512 cubic feet per minute, we are in a position to determine the proper furnace proportions with due regard to the second circumstance in producing the short flame; "initial heating of the air."

The volume of air is figured at a temperature of 72 degrees F., which will be about the temperature of air entering the valve. The increase in volume of air at different points along its travel, due to its increase in temperature, must be the governing factor in designing the ports, flue openings, etc., and as the volume of this air increases in a direct ratio to the absolute temperature, it follows that the volume occupied at any point may be computed when the temperature at that point is known.

In case of the air valve, due to the reversing feature of the furnace, this should be figured rather to accommodate the products of combustion than the entering air, as these are at a higher temperature, and will, therefore, require a greater area of flue.

The temperature of the valve is a vital point in the problem of design, for any heat beyond this point toward the stack is lost as far as the furnace is directly concerned, and can only be used in the field of economisers. In determining the size of the valve it is first necessary to determine the velocity of the products of combustion through the valve due to the draft of the stack, and this in consequence gives as the starting point, the design of the stack, which would naturally be considered as the finishing point.

A number of eminent authorities on chimney design have chosen 600 degrees F. as the most economical stack temperature. The author has never seen an open-hearth stack with that low temperature, and will, therefore, base his calculations on a temperature of 1,000 degrees F. as being more nearly uniform with current practice. The most satisfactory stack draft to be maintained is about 1 in. of water. This is a function of the height of the stack and the difference in temperature inside and outside the stack. With this difference in temperature and a draft of 1 in. of water we would get a stack 110 ft. high, and hence this may be assumed as the minimum height to be desired. The velocity of gas due to the pressure head corresponding to this height of stack and temperature, allowing a 25 per cent. friction factor, is a little less than 15 ft. per second, which is re-

* Paper read before the American Foundrymen's Association, 1911.

commended by a number of authorities as good practice.

The calculation, so far, has been based on the theoretical amount of air required for combustion, but the stack and flues may be designed, as in the case of power plant design, for an excess capacity of 100 per cent., which would be 3,000 cubic feet of gas per minute, or 50 cubic feet per second. This divided by the velocity of 15 ft. per second, would give a sectional area of stack of 3⅓ ft., or a trifle over 2 ft. diameter, and 27 in. diameter of stack will be assumed as best suited to this furnace, and plenty large enough to permit of any crowding of the furnace. This, then, will also be the size of the valve and flues leading to the valve from the checker chambers.

The second factor governing the short flames, "the initial heating of the air," spoken of before, is introduced by means of the reversing feature of the furnace through the checker chambers, and these chambers should be so designed as to slow up the travel of the products of combustion, in order that they may give up the major part of their heat to the checker brick, or that part of the heat which is not required to produce the stack draft. The cubical contents of these chambers should not be less than 75 cubic feet per ton of steel melted per heat, and preferably in the neighbourhood of 100 cubic feet per ton. These chambers should be located behind the furnace and not immediately under the furnace. This point is quite as important in small furnaces as in large ones, as they operate at a higher temperature and the benefit of a good circulation of outside air under the hearth of the furnace should be got. These chambers should be long and narrow or deep, in oil-burning furnaces, giving a very long travel to the products of combustion, before they reach the valve, as on account of the highly volatile nature of the fuel and the slowness with which many of the hydrocarbons mix with oxygen, a great deal of the fuel will be out in the stack before it has undergone complete combustion.

The methods of gas analysis as applied to steam boiler practice, will show some very interesting relations in this regard. In a 5-ton furnace which the author has been operating, a flue-gas analysis will show the following :—

	CO Per cent.	CO_2 Per cent.	O Per cent.
At the rear of the checker chambers 24 feet back of the centre line of furnace	6.4	3.1	0.2
In the air valve 9 feet further back	8.8	0.3	8.0
In the stack 16 feet further back	9.4	0.3	9.0

With a decrease in temperature between the first and last point from 1,750° F. in the rear of the chambers to 900° F. in the stack.

In case all the fuel were burned before it reached the stack the sum of the oxygen components of the flue gas would be 21 per cent., as there is 21 per cent. by volume of oxygen in all the air admitted to the furnace, the volume of carbon element being so small as to be considered zero, but as a matter of fact the sum of the oxygen components at the valve is only 17.1 per cent., and even out of the stack it is only 18.7 per cent., which shows that there is some form of hydrocarbon gas occupying the other 4 per cent. which is getting past the valve unburned and being wasted out in the stack. This shows the necessity of having long chambers and flues in oil burning furnaces to insure complete combustion of the gaseous fuel before reaching the reversing valve.

These figures are based on atomising the fuel with compressed air instead of with steam, as with steam the hydrocarbons are slower in taking up oxygen, and a gas analysis at the valve will show a higher percentage of hydrocarbon gas unburned at the valve and a corresponding increase in stack temperature. A sample of gas at the base of the stack when steam was used for atomising purposes showed the following analysis.—CO_2, 7.5 per cent.; CO, 0.4 per cent.; and oxygen, 9.5 per cent., or a total of 17.4 per cent. of oxygen components out in the stack, which is 5½ per cent. less than shown at the base of the same stack with air, and therefore, a less perfect combustion.

The third condition governing the short flame, "intimate mixture of oxygen with the fuel or diffusion," bears directly on the size and arrangements of the air ports and the furnace body. The size of the ports depends upon the size of the reversing valve, or *vice versa*, and the relation between the two is in a direct ratio to the absolute temperature at the two points, these temperatures being 1,490 degrees F. at the valve, and 2,800 degrees F. at the ports, or in a ratio of 1 to 2. The ports, therefore, should have an area of twice the area of the reversing valve, the total port area at one end of the furnace being about 7 ft. These ports should be carried out the full width of the furnace to prevent any short circuit of air through the furnace body, as the travel of gas through the furnace body should have the same velocity at all points to get the proper diffusion. These air ports should come well up above the hole in the monkey wall through which the oil burner enters the furnace, so that the air must come down on top of the flame rather than underneath it. This is a very important factor in designing a hot working furnace.

The space to be allowed for hearth in small furnaces should not be under ten square feet per ton of charge and then, too, the shape should approach more nearly a square than the oblong shapes in general use, as this tends to give a better effect of the radiation of the walls and roof, and by widening the furnace the cutting action of the flame on the side walls is lessened and the repair bills are reduced.

As to the length of the furnace body, this should be governed by the length of the oil flame, for the hottest part of the flame should be about the centre of the furnace. The author has not been able to get a flame intense enough to melt down a charge of metal any less than about 8 ft. from the tip of the burner to the hottest part of the flame, and as the tip of the burner should stick clear through the monkey wall, which will extend 9 in. beyond the ports of the furnace at least, that gives as a minimum furnace length, twice the length of the flame as mentioned above, plus twice the width of the ports plus twice the thickness of the end walls, plus twice the 9-in. extension of the monkey wall beyond the ports, or a total of about 22 ft., as the minimum length of the outside of the furnace body.

The fourth circumstance governing the short flame, "large surface of fuel presented for impact of oxygen," is a matter of oil burners and atomising agents.

There is a great deal of discussion at the present time on the needless waste of using compressed air for atomising purposes when superheated steam will answer, but in the small casting business one of the main difficulties is getting the metal hot enough to run the thin sections in the moulds, and since by its very nature, compressed air, while atomising the oil, furnishes at the same time oxygen for combustion, and that, too, very intimately mixed with the oil, it is quite evident that by using air quicker combustion, a shorter flame and a somewhat better increase are obtained.

In conclusion, in operating a furnace designed along these lines it will not be a difficult matter to get out six 5-ton heats in 24 hours, and still have the metal hot enough to pour many castings weighing a fraction of a pound each.

Titanium in Iron and Steel.

In a Paper read at the recent meeting of the American Electrochemical Society at Toronto, Mr. Charles V. Slocum, of the Titanium Alloy Manufacturing Company, of Pittsburg, Pa., referred to the work of Mr. Auguste J. Rossi with titanium, which work was continued during 30 years or more of his life, until he produced his "titanium alloy" in the electric furnace in 1903. Since that time, said the speaker, the manufacture and consumption of titanium in the steel industry had grown by leaps and bounds. Metallurgists had practically all agreed that the use of a small percentage of an alloy of titanium was of benefit in both iron and steel, but some question had arisen as to the form which this alloy should take. It had been stated that carbon-free metals dissolved more easily than other metals containing carbon, since the latter contained carbides. The experience of the author did not bear out this fact, he having found that a carbon-free alloy was not at all adapted to use in the iron and steel industry, and the manufacturers were obliged to make a product containing from 5 per cent. to 8 per cent. carbon for such use. His early experience with an alloy of iron and titanium, free from carbon, but containing 5 per cent. to 10 per cent. aluminium, resulted in almost complete failure, as the aluminium, when present in any appreciable quantity, made the steel brittle, and its oxide showed great tendency to remain in the steel.

"Titanium alloy" contained 5 per cent. to 8 per cent. of carbon, mostly in the form of graphite. Analyses of this material made in the laboratory of Dr. C. F. McKenna showed the following proportions of the two forms of carbon:—

Sample No.	Graphitic carbon. Per cent.	Combined carbon Per cent.
141	6.601	0.147
162	8.179	0.12
291	7.012	0.13
298	6.231	0.118

From these analyses it appeared that titanium acted very much like silicon in that it caused a separation of carbon as graphite.

Dr. G. B. Waterhouse recently cited an interesting experiment to bear out this fact: A ladle of iron for making malleable castings was treated with 10 per cent. titanium alloy sufficient to equal 0.1 per cent. metallic titanium added to the iron. The original iron gave castings showing a white fracture with a slight graphite in the centre. The titanium-treated metal showed a white border between $\frac{3}{8}$ and $\frac{1}{2}$ in. (1 to 1.25 cm.) deep, and a grey centre showing the separation of graphite. Contrary, therefore, to the viewpoint of Dr. Goldschmidt, there need be no fear of the non-solution of the electric-furnace titanium alloy, as it did not contain more than the merest fraction of the unreadily soluble carbide.

The density of ferro-titanium had an important bearing on its incorporation in the molten bath. Careful determinations made on the electric-furnace product containing both 10 and 15 per cent. titaniums, showed a density of 6.20 to 6.40. The alloy produced by the alumino-thermic process showed a density of between 6.20 and 6.30. The difference between the densities of the two alloys was, therefore, hardly noticeable.

The alloy was best added to the ladle of steel after tapping from the furnace and before the slag began to run. For open-hearth steel the supply should be placed convenient to the ladle and shovelled in precisely as so much coal. For soft steel an addition equivalent to 0.03 per cent. titanium was sufficient to make the steel more ductile. Larger quantities were of increased benefit, but could not always be added because of the carbon content and also because of the density imparted to the steel, which increased as the proportion of alloy was increased, and therefore was not always desirable. In high-carbon steels this increased density was desired, and more alloy was used. The addition of the alloy permitted the use of a considerably higher carbon without increasing the brittleness, and several railways were now using as much as an equivalent of 0.10 per cent. titanium or more in securing tough, durable rails.

In crucible-steel practice the best results had been obtained by adding the titanium alloy to the pots before they were removed from the furnace, giving more time for washing and deoxidising before teeming.

Leading authorities seemed to agree that titanium achieved its remarkable results through its strong deoxidising powers, together with its effect of giving the slag formed sufficient fluidity to completely separate it from the metal.

Mr. Bradley Stoughton had stated that the presence of titanium oxide lowered the melting point of slags occluded in iron and steel and imparted thereto sufficient fluidity to account for their elimination.

Mr. Henry M. Howe had pointed out that titanium had a stronger affinity for oxygen than had the well-known deoxidisers, and that it probably gave the slag such a consistency that it separated more completely from the molten iron.

Mr. H. le Chatelier, in a Paper at the Congress of Metallurgists in Belgium, in 1905, remarked that the treatment of all steels with ferro-titanium for the purpose of purifying the metal was strongly recommended, the presence of nitrogen to the extent of 0.02 to 0.035 or 0.045 in certain steels being enough to cause the metal to break asunder, destroying all elongation and reduction of area.

The cost of treatment with titanium varied from a mininmum of 1s. to a maximum of 8s. per ton of metal treated. It was the cheapest deoxidiser above the grade of manganese or silicon, and a far greater purifier than any other alloy. The amount to be used was very small, and should be proportioned according to the carbon content of the steel and to the amount of impurities present. To the electro-metallurgist it was a triumph worthy of record that Rossi should take an element like titanium, so long considered useless, and make out of it so wonderful a servant to the iron and steel industry.

Mr. Slocum's Paper brought forward a lively discussion.

Mr. Wm. C. Cuntz, of the Goldschmidt Thermit Company, read a communication from Dr. Hans Goldschmidt, who first replied to Mr. Slocum's claim that a carbon-free ferro-titanium was not adapted for use in the iron and steel industry, and emphasised that this claim was refuted by the undisputed practical results obtained by a number of prominent metallurgical works which use continually carbon-free ferro-titanium. He (Dr. Goldschmidt) did not claim that ferro-titanium containing carbon was unsuitable or useless. But he claimed that the carbon-free ferro-titanium containing aluminium was a more effective reagent.

Multiple Moulds on an Ordinary Machine.

By T. F. Hardyman.

Are foundrymen sufficiently acquainted with the advantages of the multiple moulding system and the enormous saving it effects? Some are, but the majority do not know what multiple moulding is. Those who do understand the system often say that the capital outlay on muliple moulding machines, boxes, pattern-plates, etc., is prohibitive, and their firms would not entertain the idea of taking out the old machines and installing new multiple machines

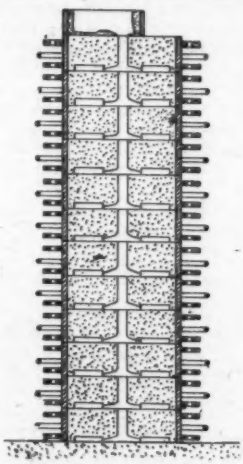


Fig. 1.—Section of a Stack of Multiple Moulds.

in their place. But in nine cases out of ten this system would very quickly pay for itself, even if a plant was installed on an elaborate scale. (These remarks, of course, refer only to repetition work.)

The writer will endeavour to explain a practical, effective and very cheap method of multiple moulding which can be operated on an ordinary hand-pressed or an hydraulic moulding machine, the only extra cost being in some cases an additional pattern-plate.

Economy of the Multiple System,

Fig. 1 shows the cross-section of a multiple mould of flanges. It will be observed that one box part acts

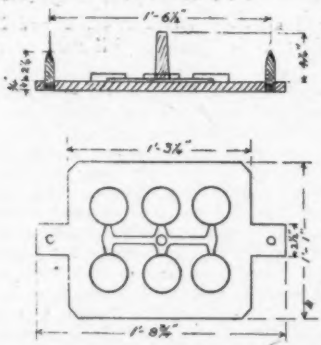


Fig. 3.—Multiple Pattern Plate of Flanges.

as top and bottom part together, with the exception of the top and bottom part of the stack, thus effecting a saving of nearly 50 per cent. in labour for this alone, but in addition as many as ten to twelve sets of moulds can be cast with one runner, one runner bush, and one set of weights, therefore in the case of casting twelve sets of moulds a saving of eleven runner bushes is effected, and this saving in bushes is not confined to the making up of the bushes, but it will also save the metal that would otherwise be poured into eleven other bushes, saving approximately three-quarters of a hundredweight per stack. One man

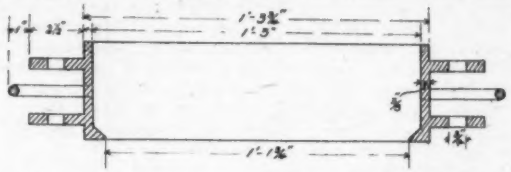


Fig. 2.—Section of a Machine Moulding Box.

making, say, six stacks a day would save 4 cwts. 2 qrs. per day, which would be very considerable at the end of the month, in conjunction with the saving in the cost of melting the metal and the depreciation of the iron. Further, presuming single boxes moulded in the ordinary way require two half-cwts. each box,

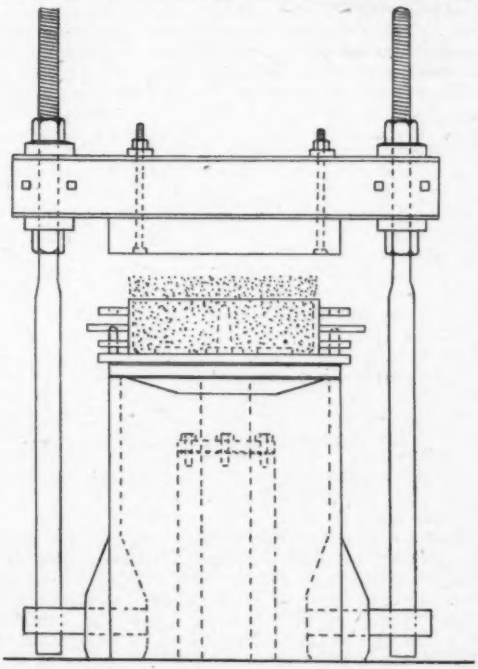


Fig. 4. Multiple Mould Ready for Pressing.

a multiple stack of twelve moulds will require only four half-cwts., which will save the time and exertion of handling twenty half-cwts.; also what may prove of highest importance in some cases, is the great saving in floor space. The castings made in this manner, too, are much sounder, freer from blow-holes

and absolutely free from sinkings, owing to the pressure under which they are cast. The castings will also cool much slower and will therefore be softer than if moulded in the usual way.

Fig. 2 shows a machine moulding box, the dimensions of which are 15 in. by 13 in. by 4½ in. deep and ⅜ in. thick, with two snugs each end, which have ¾ in. holes in them drilled to a jig. It also has ⅝ in. internal heads. This size of box will be found most useful, as it will cover a large range of different work; one advantage it may have over some boxes is the internal heads which make it impossible for the mould to drop out. It is not essential for these

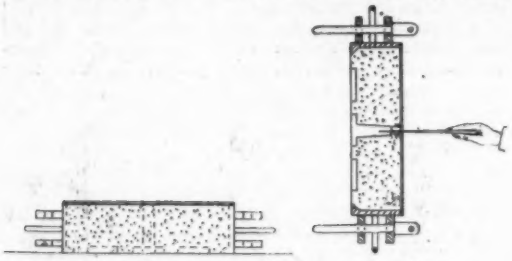


FIG. 5.—OPENING RUNNER BEFORE CLOSING FIRST MOULD OF STACK.

boxes to be machined, providing the top and bottom edges are comparatively smooth, free from swellings, etc., but machining would make a nicer job. The writer strongly recommends this size box, but, of course, where there are already machines at work they will use the boxes they already have.

Fig. 3 shows the cross-section of a pattern-plate of flanges for the above box. These plates should be machined on both sides, unless they are made in the manner explained later. Git runners must also be fitted or cast to the patterns, and a wooden vertical runner fitted to the git runners and pulled down tight by

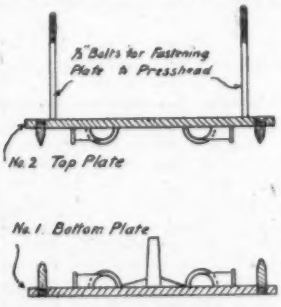


FIG. 7.—MULTIPLE PATTERN PLATES FOR HOLLOW WORK.

a wood-screw put in from the back of the plate. The overall height of this vertical runner from face of plate must be ¼ in. less than the depth of the moulding box; in other words, the top of the vertical runner must be ¼ in. below the top of the moulding box when the box is on the plate. It is essential to have as much taper as possible on all patterns that are to be moulded from on the multiple system, as it is very inconvenient and troublesome to repair these moulds; in fact, it is cheaper to knock the box out and make a fresh mould.

Cheap Pattern Plates.

A good way to make these pattern plates cheaply is to have a plain pattern plate machined on both sides; then take the wooden patterns, the number of which will be governed by the size of the patterns and moulding box, and stick them on the plate with shellac varnish. When the shellac has dried it will require a sharp blow with a hammer to remove them. The plate with the patterns stuck on, is then taken into the foundry and a good, smooth mould made from it. When cast, the casting should be stripped and crossed from corner to corner; that is to say, while the plate is red-hot the casting should be bared from corner to corner in the shape of an X, the bared parts to be about 2 in. wide. This will prevent the plate curling or warping.

When cool, the plate is dressed off and filed where necessary, and the centres for the pins are then marked off, drilled and tapped, and the pins screwed in Two holes and cheese-headed screws are also required with which to fasten the plate down to the machine. The plate is then warmed up and given a coating of beeswax or linseed oil and allowed to cool down again, after which it is ready for use.

Multiple Moulding.

The foregoing operations completed, the plate is screwed down onto the machine, and a box placed

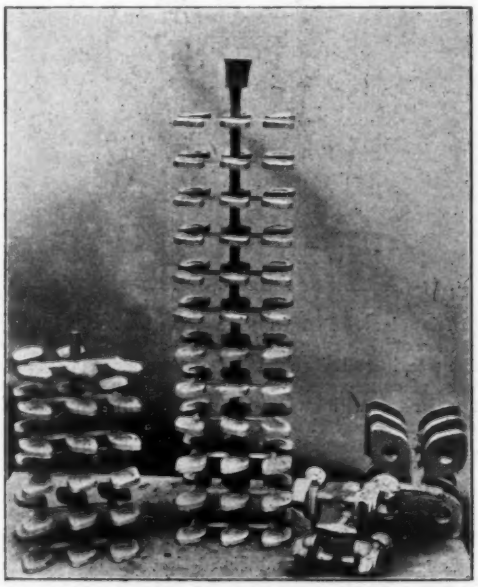


FIG. 6.—SET OF FLANGES MADE IN MULTIPLE MOULDS.

on the plate (see Fig. 7). Facing sand is sifted on, and the moulding box filled with black sand to about 2 in. above the top; then another thin layer of facing sand is sifted on the top of the black sand. The presshead, which has an iron plate or stout board, 1 in. larger all round than the moulding box, bolted to it, is then pulled into position over the moulding box and pressed in the usual way. The mould is removed from the machine and placed on a level bed on the foundry floor, this being the first box of a multiple stack. The vertical runners must be stopped off (see Fig. 1), as the top of the first box forms the bottom of the first mould, and the underside of the first box is wasted.

It will be noticed that a layer of sand is left on the top edges of the moulding box after the pressing of the mould is completed. This layer of sand

must not be removed, as it forms a perfectly level bearing surface for the bottom of the next box.

After the vertical runner has been stopped off, and the flat surface blacked and sleeked, the moulding of the second box is proceeded with. This is made in the same manner as the first. When pressed the mould is removed from the machine, and two removeable box pins are dropped in the snug holes ready for closing the mould; but before closing it the thin layer of sand which has been left between the top of the vertical runner and the presshead must be cut through with a cleaner (see Fig. 5). The box is then placed on top of the first box, and the process is repeated until a stack of ten or twelve boxes is made. A fresh stack is then started.

Owing to the strain to which the lower moulds are subject, the bottom boxes must be pressed harder than the top ones, or they will swell and strain. Fig. 6 shows a set of 72 flanges moulded and cast in this manner.

Moulding General Castings.

The moulds made in the manner explained above are termed flat backs. Moulds which are apparently more difficult, but which are in reality just about as easy to make as the flanges, will now be considered. All that is required is an extra pattern plate, or rather a duplicate of the one which is screwed onto

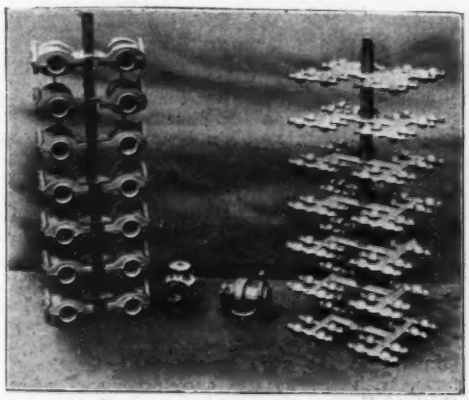


FIG. 8.—STACK OF CASTINGS MADE IN MULTIPLE MOULDS.

the machine table. This extra plate should overlap the sides of the moulding boxes about 1 in. all round, as in the case of the flanges. Fig. 7 shows the cross-section of a pair of these pattern plates for moulding small branch pipes on the multiple system. Plate No. 1 is fastened down to the machine, and a box is then placed upon the plate. Plate No. 2 is then placed on top of the box with the pins of the plate inserted in the top snug holes of the moulding box, the presshead is pulled into position, and the moulding box and plates are pressed up to it. The plates and box must be kept pressed up to the presshead in this manner until the top plate is bolted right into position by bolts let into the pattern plate, as shown in Fig. 7. This process of fastening up the top plate will insure the pins of this plate coming into a straight position over the holes in the upper snugs of the moulding box on the machine. Unless the plate is fastened up in this manner there will be a danger of breaking off the top snugs of the box when pressing the mould, owing to the pins not being directly over the holes and catching on the snugs.

When preparing these plates, care should be taken not to have the pins too long, or when pressing the mould it will be found that the pins will touch each other before the mould has been sufficiently pressed. The pins of the upper plate must also have a large amount of taper; in fact, they should taper to a sharp point, so that once the pin-points enter the snug holes the presshead will centre itself. When the plates have been fastened in the correct positions, the box is lowered away from the presshead, the facing sand is sifted onto the bottom plate, and the box filled with riddled black sand to about 2 in. above the top of the box. Another layer of facing sand is then sifted on the top, and pressed in the same manner as the flanges.

Fig. 8 shows a stack of these castings made in the above manner. In cases where there is only a very thin partition of sand left between the moulds when pressed, owing to the boxes being too shallow, it will be found that by putting a small taper riser on the bottom pattern, the point of which is, say, ¼ in. shorter than the space left between the patterns when the mould is pressed, and afterwards opened out with a cleaner, there is very little danger of the moulds bursting into each other.

Progress in the Electrometallurgy of Iron and Steel.

In a Paper read before the Faraday Society on October 3 last, Mr. Donald F. Campbell remarked that the refining of steel by electricity is of great interest, both on account of its high state of development, wide application, and its economic importance in Britain. A few years ago the best steel could only be made from the purest minerals, the domestic supply of which is approaching exhaustion. Now pure steel of excellent quality can be made from inferior ores, such as those of Cleveland and Lincolnshire, and the price of power in England is sufficiently low to make this a profitable operation.

Statistics show that the rate of growth of electric refining has been more rapid than that of other important processes, and the output of electrically-refined steel for five important countries has risen from approximately 30,000 tons in 1908, to 120,000 tons in 1910, and a further increase will probably be recorded this year.

Perhaps this is due to its varied application, as it has been already found profitable for the manufacture of many classes of tool and special steels and castings. But the question that is now before progressive steel-makers is of much greater significance. Will the electric furnace, which has already absorbed over 30 per cent. of the high-class steel trade, be applied generally, in conjunction with the basic- or acid-Bessemer converter, to compete with open-hearth steel in the matter of cost? At present it can only compete with best acid open-hearth steel for price, though in quality it is superior to any steel made by these methods, and consequently its general adoption would mean an improvement in quality which is now so necessary to meet the requirements of modern engineering. Many steel-makers think it impossible, but German and American engineers are giving this problem the most serious consideration, and several 20-ton electric furnaces are now being erected with complete confidence to prove the economy of this very application as a duplex process.

Progress both in the metallurgical and mechanical details of the steel furnace is continuous. Two years ago the power consumption used for melting and refining cold scrap under best conditions was 750 kilowatt-hours per ton, but one furnace in England has required a power consumption of only 575 kilowatt-hours per ton for the last 527 tons manufactured.

Works of the Metropolitan Railway Carriage and Wagon Company, Limited.

Visit by Birmingham Foundrymen.

The Birmingham Branch of the British Foundrymen's Association opened their Autumn Session on Saturday, October 7, with a visit to the extensive works of the Metropolitan Amalgamated Railway Carriage and Wagon Company, at Saltley, Birmingham. The establishment is one of the finest and best equipped among those devoted to the building of railway rolling stock; and the invitation of the directors was, naturally, well responded to. About 70 Members were present, divided into parties under the guidance of Messrs. E. Giles, chief engineer; F. E. Morgan, foundry manager; J. Martin, engineers' draughtsman; W. Clegg and W. Reginald Wright.

The Company incorporates and includes the following works:—The Ashbury Railway Carriage and Iron Company, Limited; Brown, Marshalls & Company, Limited; the Lancaster Railway Carriage and Wagon Company, Limited; the Metropolitan Railway Carriage and Wagon Company, Limited; the Oldbury Railway Carriage and Wagon Company, Limited; Docker Bros., Limited; the Patent Shaft and Axletree Company, Limited; and the Willingsworth Iron Company, Limited.

The Saltley Works are the largest of the group of five wagon-building establishments in the amalgamation, covering about 43 acres and employing about 2,200 men. The works are now producing to their utmost capacity, and have a number of large orders passing through the various shops, the largest being a contract for 7,500 wagons for the Great Central Railway, of which nearly 2,000 have been completed. Of the shops, the largest was the wagon-building shop, in which the various parts, made in different sheds, are assembled and fitted together. The building is 800 ft. long by 250 ft. wide. In this shop some wagons of unusual size, for a South American Railway, were in course of construction.

Naturally the foundry absorbed most interest, and as the visitors were a body of skilled foundrymen this department came in for critical and detailed examination. The complete orderliness and ample elbow-room, and generally airy dimensions received general commendation. The inspection was materially assisted by the full explanations of Mr. F. E. Morgan, the foundry manager, who had several interesting items to show in the way of moulding machines. All the brass, gun-metal, and iron founding is carried out under one roof, under Mr. Morgan's personal superintendence. There is a remarkable variety of work carried out, mainly owing to the pronounced individuality of the specifications, nearly every railway having its own ideas in regard to detail. Axlebox patterns, for example, number at least 500. There is a special machine for the testing of axleboxes, in which fittings, high quality has to be associated with exactness of size. A very useful machine is the Roberts disc grinder, which produces a perfectly smooth surface merely by hand pressure of the metal against the grinder. It finishes much more smoothly than a mechanical plane. Another machine drills a casting with several holes at once from above and below.

The moulding department makes the fullest possible use of machinery. A "Coventry" moulding machine, by the Britannia Foundry Company is being used for small axleboxes, and will turn out as many as eighty moulds in a full day's work by two men. Another very useful machine is the McClelland, which raises the mould to the stripping plate. This is worked with air pressure at 100 lbs. A second machine was made to the firm's own specifications, and is of very similar construction, for the production of axleboxes. This machine will produce 40 boxes per day, weighing about 80 lbs. each, with the aid of four labourers.

For a number of years the whole machinery of the establishment has been operated by electricity. The power-house is equipped with four 250-kw. sets, and one 600-kw. turbine, the engines being furnished by Messrs. Belliss & Morcom, Limited, Birmingham, and the generators by Messrs. Willans & Robinson. The full capacity is 1,660 kw., but the normal load is about 800 kw. The whole of the lighting is by electricity, and the total production last year was about 2½ million units.

Passing through the wood-working shops, the visitors greatly admired the wood-cutting machinery, which includes milling, slotting, planing, cutting, drilling, and carving machines. A large band-saw for cutting up the teak logs is capable of dealing with a log 4-ft. square, the saw travelling at the rate of a mile and a-quarter per minute. The power of this is furnished by a 50-hp. motor. One of the busiest departments in the establishment is the smithy, equipped with 42 steam-hammers varying from 5 cwt. to 3 tons in weight. A remarkable variety of steel fittings are forged and stamped out in this shop, comprising brake levers, drawbars, buffers, chain links, etc.

Completing the visit, the party re-assembled in the Drill Hall. Some curosity was aroused by a row of four large naval guns 4.7-in. calibre; and it was explained that the workmen were among the first to form, with the hearty encouragement of the directors of the concern, a company, 209 strong, of the South Midland Battalion of the Royal Garrison Artillery. In the large mess-room some 2,000 workmen are regularly catered for, and an excellent rifle range is also equipped for miniature rifle practice.

Before separating, the visitors gathered in the mess-room to offer their acknowledgments to the directors of the company for their invitation, and to the guides for their help in directing the tour of the party. Mr. H. L. Reason (Branch President), in moving this expression of thanks, said this was one of the best visits the local Branch had ever had. They wished specially to acknowledge the kindness of Mr. Giles, Mr. Morgan, and their fellow guides in conducting the parties.

Mr. C. Heggie seconded, and the resolution was carried with acclamation.

The resolution was carried with acclamation.

Mr. F. E. Morgan responded to those expressions of thanks, remarking that he had a great regard for the British Foundrymen's Association. He could assure them that in that factory everybody had to be up to concert pitch. But there were great provisions made by the Company for the comfort of all the foremen and workmen, and he was proud to be connected with such a firm.

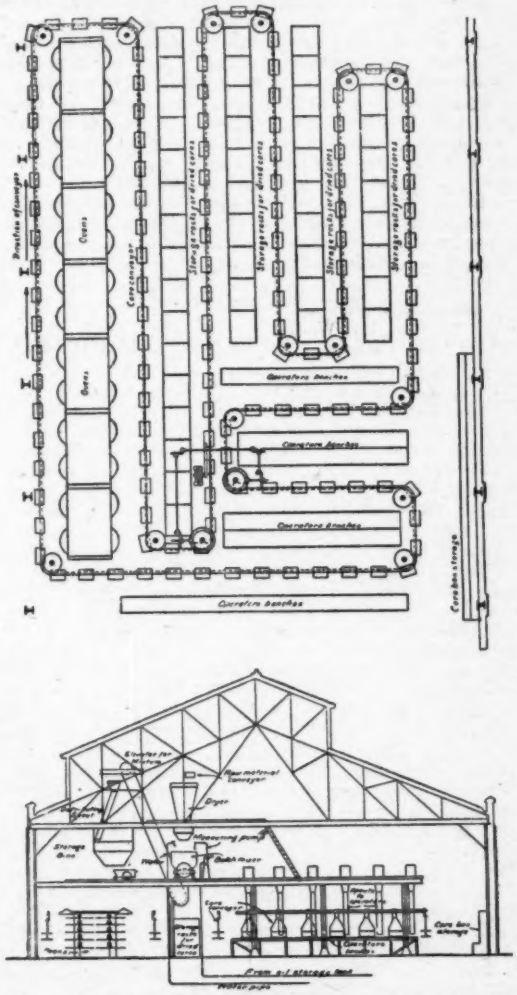
Economies in Core Making.*

Various elementary labour-saving devices in connection with core-making have been adopted from time to time—such as power sand sifters, power mixers, multiple core boxes, mechanical squeezers or ramming machines, etc.; and some attempts have been made to save labour in handling cores to and from ovens and storage racks; continuous ovens have been devised. All of these measures have met with some success, though lacking in elasticity, as well as other essential features. But the increasing size of foundries has made it worth while for the engineer to study the problems offered.

A plant embodying many novel features, from plans by Mr. Hooper, of the Hooper-Falkenau Engineering pany, New York, has lately been put in operation, and has done its work with satisfactory speed and good economy. The process begins with the raw sand brought by conveyor from the storage bin into which it has been dumped directly from the cars. This conveyor delivers the sand directly into a drier beneath which is a storage bin, which in turn, discharges directly into a batch-mixer beneath it. At the side of the batch-mixer are a measuring pump for oil and the water and oil valves, all operated by the labourer who handles the mixer. The mixer discharges into a belt elevator provided at its upper end with a swinging spout which discharges different mixtures into separate bins. From the bottom of these bins the various mixtures are dropped into a barrow which runs on an elevated platform above the core-makers' benches. Above each bench and extending to within a few inches of it, is a galvanised chute open at the lower end. The mixed sand that is poured into this chute forms of itself a natural stop, the mixture flowing down as the pile at the bottom diminishes through use. So far there is little out of the ordinary, save the use of the drier; although it may be noted here that two labourers handle easily all of the above work and could probably handle a tonnage half again as large with no over-exertion.

For the next stages of core-making, however, a number of unique features are in use, as will be seen from the accompanying illustration.

Attention should first be given to the compactness of the general arrangement which puts the core-makers' benches close to the battery of ovens; while near to both benches and ovens is a set of cooling and storage racks. Passing close to all of these in such manner as to serve them all is a conveyor consisting of cars of two shelves each, suspended at about bench height from an overhead rail, and pulled by means of a chain above and supported by the cars. This conveyor serves a number of operations, as follows: It carries green cores from the benches to the ovens and baked cores from the ovens to the cooling and storage racks; cores from the storage racks as desired to unloading stations, whence they may be carried to the moulders; and finally it returns core boxes, driers and trays to the core-makers' benches. The conveyor is of simple design, consumes only about two horse-power, and after a year or more of operation is declared to break fewer green and baked cores than hand transportation. Through its use the operative at any station does not leave his place. When the green cores are made, the drier, box or tray containing them is placed upon the carrier by the core-maker, who has merely to turn half-way round to do so. At the ovens the green cores are received by the oven attendants and placed directly upon the oven shelves awaiting them, the dried core being then placed upon the carrier for carriage to the storage racks, where they are taken from the driers, boxes or trays, which latter are again placed upon the carrier to be returned to the core-making benches. If necessary a station for washing and drying the trays and boxes can be established in the circuit at a convenient point ahead of the core-making benches. The labourers at the racks also load cores as desired upon the carrier for delivery at unloading points along the line of the carrier, whence they may be taken to the moulders.



Diagrams showing Arrangement of Core-making Plant.

The ovens are as interesting and satisfactory as the carrier. Since, in this particular foundry, there are nine different shapes and weights of cores to be baked, there being also four different mixtures, and a total production of about 30,000 cores per day, it will be recognised that a difference must be made in the baking of the several kinds of cores; while at the same

* "The Canadian Engineer.

time the continuity of operation of the system must be retained. The ovens, therefore, which are fired by oil, are built with independent circular shelves of varying sizes to accommodate the various cores; and the shelves are made of two sections separately by a baffle plate which closes the oven and forms the oven front. Thus one-half of the shelf is within the oven and half outside. Shelf room is thus always available for storing the green cores brought by the conveyor, this storing being in effect a new loading of the oven, since by revolving the shelf a half turn to withdraw the baked cores, the half of the shelf that carries green cores is swung into the oven.

Ventilating apparatus is provided consisting of hoods over the fronts of the ovens connected with exhaust apparatus. This removes the very disagreeable fumes arising from the baking of oil cores, and enables the oven chargers to work close to the ovens, as their duties require, without discomfort.

Service of over a year and a half has proved that this type of oven works thoroughly well in connection with such a continuous system, there being no lack of capacity or accommodation for the variety of cores brought to the ovens. This type of oven is not patented; it is said upon good authority, that no patent can issue upon it. Every one is free, therefore, to make what use of it is possible.

It will be at once realised that the flexibility of this continuous system takes it out of the class of special apparatus and renders it available for any foundry having a sufficient tonnage.

Annealing of Non-Ferrous Metals.

The Birmingham Section of the Institute of Metals began its second session on October 10 with a further discussion on the annealing of non-ferrous metals.

The CHAIRMAN (MR. G. A. BOEDDICKER) said that his idea in starting the discussion was that they wanted to see what could be done at a small cost to improve the annealing furnaces they had. There were two types of furnaces, the open or inflame, and the closed muffle furnace, which could be fired either by coal or gas. Personally, he was decidedly in favour of the closed muffle, especially where the work was continuous. On the other hand, an inflame furnace had the great advantage of being very quick, not only in annealing but also in getting up; and where the work was not continuous and a furnace had to be used for a few hours every day, the advantage undoubtedly lay with the open furnace. The ordinary Birmingham type of coal-fired muffle should, he thought, be rejected altogether. It was not economical, the temperature was very uncertain, and a great deal of dust must be blown over which settled on the metal. If an open furnace had to be used at all it should be gas-fired, either from a small producer attached to the muffle or from a central producer supplying a number of furnaces with gas. The combustion of the gas should take place above the metal so that this could not be reached by the flame. The inlet of the gas therefore should be at least 12 in. above the hearth. In closed muffles the question arose whether an iron or a firebrick muffle was the best. At the first glance it would appear that iron, as a good conductor would be most economical. But iron after a short time began to grow, and gradually got covered with a layer of oxides which were very bad conductors indeed. On the other hand, firebricks, which were bad conductors when cold, were good conductors of heat when red-hot, and the iron muffle should be discarded altogether. The firing of a closed muffle should preferably be done by gas, but whether fired by gas or coal a large combustion chamber should be provided. He (the speaker) was in favour of separate producers attached to each muffle. In that case they did not require any flues or stack, a small chimney of 15 or 20 ft. being sufficient, and no leads for the gas were needed. They would have the firing absolutely under control, and in his opinion separate producers attached to the muffles were more economical, because the initial heat of the gas was not lost through a long lead. The importance of the combustion chamber was very clearly illustrated in a small annealing muffle at one of the works of his firm. This muffle had an open fireplace, and the flame travelled through flues about 6 in. high underneath the hearth to the front, then passed back over both sides and then over the top into the chimney. As the combustion of fuel was very considerable, he altered the muffle by making the flue under the hearth 18 in. instead of 6 in., thus effecting a perfect combustion and a very considerable economy. As to the furnaces with a non-oxidising atmosphere, he had had no experience with them except as to the Bates and Peard furnace for the annealing of wire. As to the Bates and Peard muffle, he found the iron retort very unsatisfactory, because it was such a bad conductor of heat. It did not work economically at all; but since he had altered the furnace by substituting a firebrick retort for the iron one, and by replacing the old fireplace with a Gibbons gas producer, the furnace had been vastly improved. It had now been working for fifteen months without any repairs, and when examined a few days ago was found to be in splendid condition. With regard to pyrometers, he did not think their continuous use absolutely necessary, except in muffles of the Bates and Peard type, where it was very difficult to see the temperature inside the muffle. A careful annealer soon found whether the metal was not annealed sufficiently or whether it was burnt, and really, the cases in which a man went wrong were very scarce indeed. In an open muffle it was exceedingly difficult to place a pyrometer so that it should give the correct temperature of the metal being annealed; whilst the closed muffle, with its very even temperature, offered no difficulty in that direction. To sum up, he recommended a gas-fired muffle if possible; if an open muffle were used, it should be gas-fired. Under all circumstances, whether with gas- or coal-fired furnaces, a spacious combustion chamber should be provided, so as to ensure perfect combustion, and greater economy.

MR. J. W. EARLE said the open muffle had the advantage that different grades of metal were more easily dealt with in it at the same time than in the closed muffle. They frequently had copper, German silver, white metal, dipping metal, and yellow metal being annealed together; he had seen muffles with all those different grades of metal in them at one time. The man had to use his discretion as to the portion of the muffle in which he put each metal. The closed muffle possessed great advantages, particularly in dealing with metal in the thinner stages, and there was probably less danger there of the metal getting burnt than in the open muffle. The open muffle must be watched very closely, particularly in the thicker stages, because it was in those stages, generally speaking, that the metal got damaged by over-annealing.

MR. A. SPITTLE said that he had had some experience with the Féry pyrometer as well as with the thermo-couple. With a closed furnace the Féry was undoubtedly the better instrument, but with the open type of muffle the records could not be true because the intervening flame was not perfectly transparent. The pyrometer was not a safe instrument to put into the hands of an average workman, unless it recorded, as it might serve as a scapegoat for the man's neglect.

The Stove-Grate Trade of Sheffield.

Address before the British Foundrymen's Association.

Mr. W. F. Bagnall, of Sheffield, was the lecturer at the meeting of the Sheffield Branch of the British Foundrymen's Association, held at the Rooms of the Literary and Philosophical Society, on Tuesday, October 24. Mr. Percy Longmuir, President of the Branch, was in the chair, and there was a large attendance.

Mr. Bagnall's subject was "Art as Expressed in Castings," and he read the Paper which he gave at the Annual Convention of the British Foundrymen's Association in Glasgow in August. The lecture was illustrated by many slides, showing beautiful art patterns of stove-grate and other castings, many produced at Sheffield and Rotherham, and others in Scotland. Mr. Bagnall referred to the fact that time was when people were willing to spend £500 or £600, or even up to £1,000, on the supply of artistic stove-grates for a mansion, but it was very unusual for £100 to be expended for that purpose to-day. This particular branch of the trade called into being a set of workmen—a more appropriate title would be artists—who were not generally met with in ordinary foundry practice. These included designers, modellers, wood carvers, chasers, and men specially trained for filing and otherwise dealing with the cast-iron patterns made, in many instances, from the master patterns. No rule-of-thumb man would be successful in producing the examples of artistic castings with which Mr. Bagnall's Paper treated. The moulder for this class of work must have skill of a very high degree, careful training, steady hand and nerves, pride in his work, and, above all, brains.

The neighbourhood of Sheffield and Rotherham a generation ago led the world in the production of high-class stove-grates. The number of firms producing these, had, however, largely decreased, and the district of Falkirk and neighbourhood probably held the premier position to-day. Though the number of firms producing these articles was much less than of yore, one or two Sheffield and Rotherham firms still brought out high-class artistic stoves, equal to any than can be produced in any part of the world. Sheffield's pre-eminence in the production of these high-class stoves in the 19th century was due largely to the designs of Alfred Stevens, who was for some years employed at the Green Lane Works of Messrs. H. E. Hoole & Company, and was assisted for some part of the time by Godfrey Sykes.

The President remarked that though he was not an artist, he had enjoyed looking at the artistic illustrations which Mr. Bagnall had put before them. Many of them must have experienced a slight tinge of regret when they heard how this art industry had migrated to Falkirk. But, although much of the trade might have gone, they had seen that all the art had not gone, and the magnificent examples exhibited had shown them that there were still men in the Sheffield district who could design and produce a beautiful art casting. Alluding to Mr. Bagnall's reference to Aristotle and cast iron, he thought that was rather early for cast iron. In all probability the iron referred to by Aristotle was not at all comparable with the present-day cast iron. Many of them had no doubt been to Hampton Court, and there seen the examples of fine old cast-iron fire-places—some of the best examples possibly that England possesses.

Mr. G. Wright (Rotherham) disagreed entirely with Mr. Bagnall as to the very beautiful productions they had seen having left the Sheffield and Rotherham district. That was not so. Falkirk was not able yet to produce what Sheffield could. The Carron Company had certainly produced some very fine castings, but the Sheffield district still led the way. Sheffield did not lay herself out for the cheap castings, but to say that the bulk of the trade had left the district was wrong. Sheffield and Rotherham could produce anything equal to what had been shown that evening, provided they could get the order for it. But there was the difficulty. There was no demand for the ornate to-day. The demand had gone by. There was some craze for Louis art; it was undecided whether it was the thirteenth, fourteenth, fifteenth or sixteenth Louis, but there was some demand for French renaissance and a slight feeling in favour of Jacobean. But the stove-grate trade to-day was dependent upon the architect. When the things they had seen on the screen that night were produced, that was not so. But to-day the architect had more voice in regard to the internal decoration of a house than ever he had, and he did not order ornate and expensive stove-grates like those shown by Mr. Bagnall.

Mr. J. G. Hyde referred to Ruskin, who, in early life, had a very low opinion of cast iron, because he seemed to think it was an entrenchment into the province of the skill of the blacksmith, and he did not hesitate to say so. But, later, he modified his views, and gave the art of the ironfounder a higher place in his thoughts.

Mr. Charles Green, one of Sheffield's best-known artists and sculptors, said that for fifty years he had been a designer, and he was still in harness. Many of the men who designed the beautiful stove-grates Mr. Bagnall had shown were friends of his in days gone by. He knew well John Bell, Alfred Stevens, Godfrey Sykes, and a host of others—pioneers of art in the cast-iron trade. He had been collecting Sheffield iron work for several years, and he had a fine collection of early Sheffield specimens. He was sorry that the city did not possess a collection, showing what the craftsmen of years gone by could do. There were three beautiful stove-grates in High Hazels Park Museum, but many of the finest specimens were disappearing from their midst. He wanted Sheffield to possess some of the work of Alfred Stevens, samples of whose splendid work they had seen that evening. Some beautiful work was to-day turned out at Falkirk, but Sheffield could still hold is own against anybody.

Mr. Bagnall, replying to Mr. Wright, said he made it clear in his Paper that Sheffield could still produce artistic work equal to any in the world.

Hearty thanks to Mr. Bagnall were carried, on the motion of Mr. T. H. Firth, seconded by Mr. J. G. Crowther, and supported by the President.

Mr. Crowther, in his speech, said Sheffield was not yet going to the wall in its art craftsmanship. As good things were turned out to-day, and as beautiful, as years ago. But a stove-grate manufacturer said to him only recently, that people wanted a house to-day for the same money as they gave for a stove-grate years ago.

Foundry Plant and Equipment.

The Foster Fixed-Focus Radiation Pyrometer.

Pyrometry, originally belonging almost exclusively to the domain of the laboratory, is now employed largely in actual works practice. This enlargement of the pyrometric field frequently calls for change in design. Complications or mechanical delicacy, which gave no trouble in the laboratory, have proved great embarrassments in works practice. To meet some of these rougher conditions the fixed-focus radiation pyrometer has been introduced by the Foster Instrument Company, of Letchworth. In this instrument the user is not called upon to perform any manipulation or adjustment in use. The design is based upon certain well-established physical laws. The heat energy radiated by any hot body increases very rapidly with a rise in temperature; consequently for high temperatures the radiation pyrometer is particularly suitable.

The law according to which hot bodies radiate is known as the Stefan-Boltzmann Law or the Fourth-Power Law. It may be stated as—$E_1 = K (T_1^4 - T_2^4)$. Where E_1 is the energy interchange between a hot body at absolute temperature T_1, and an instrument at absolute temperature T_2. From this law, which has received full confirmation and is generally accepted, it follows that an increase of 1 per cent. in the absolute temperature of any hot body results in an increase of 4 per cent. in the energy received by the instrument. The converse is also true, namely, that a change in the sensibility of the instrument of 4 per cent. would only result in an error of 1 per cent. in the measurement; therefore the radiation pyrometer should have great permanence in its readings. It is further to be observed that heat radiations obey the same laws as light radiations; in fact, they are one and the same phenomenon, though the eye is only sensitive to the shorter wave lengths known as light. Heat radiations may be reflected and concentrated by being brought to a focus.

In the foregoing laws we have the elements of a radiation pyrometer. Radiant heat from the hot body under examination may be focussed on to a thermo-couple junction, thus heating it and causing an electric current to flow. Suitable construction and calibration make this current a measure of the temperature of the radiating body.

In Fig. 1 is shown a diagrammatic section of the receiving tube of the radiation pyrometer under notice. At the front end of the tube M N P Q is an aperture E F. Radiant heat from any hot body such as A B enters the aperture E F, and is received by the concave mirror C. The proportions of the instrument are such that this mirror forms a focussed image of the aperture E F on a thermo-couple junction situated at D. This focussing is done once for all before the instrument is calibrated and has not to be altered in use even when the instrument is used at varying distances from the hot body under examination. In order to secure this independence of distance it is necessary that the aperture E F, as would be seen from all parts of the mirror C, should appear filled with radiation from the hot body, and when this is so the operation is independent of the particular distance. Looking at Fig. 1 it will be seen that cone E G F limits the angle of vision from the

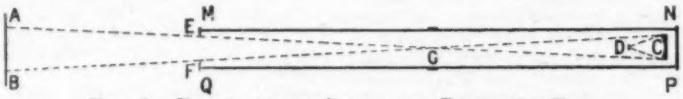


Fig. 1.—Diagrammatic Section of Receiving Tube of the Foster Fixed-focus Pyrometer.

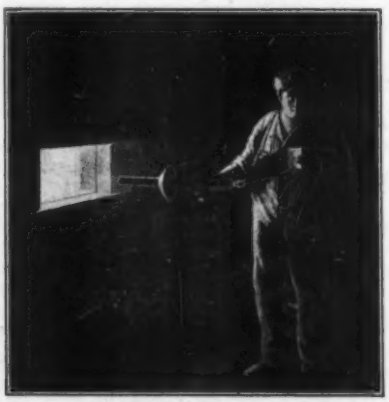


Fig. 2.—The Foster Pyrometer in Use.

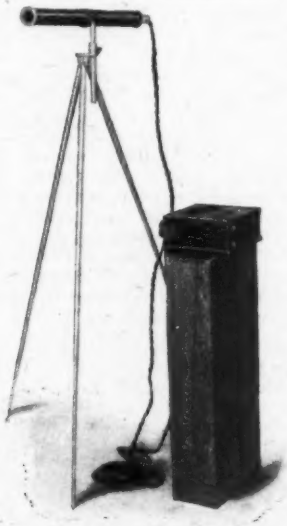


Fig. 3.—The Foster Pyrometer Mounted on Tripod.

mirror; it is therefore only necessary that the hot body surface shall fill or over-lap any section of the cone E G F extended. In practice this results in the simple rule that the maximum working distance must not exceed a certain multiple of the hot body diameter. It may be anything less than the maximum without affecting the reading of the pyrometer; therefore the working distance has usually not to be measured accurately.

In the standard instruments the multiple for working distance is ten for the range 700 degrees to 1,400 degrees C., and twelve for the range 900 degrees to 1,800 degree C. For instance, if the peep-hole into an annealing furnace measured 3 in., the maximum working distance would be 30 in.; or, for the high-range type, if the door of an open-hearth furnace were open 6 in., the maximum working distance would be 72 in. In all cases the distance is measured from the hot body surface, or the inner edge of the peep-hole, to the centre ring on the receiving tube, this marking the apex G of the limiting cone. This geometrical result of the construction of the receiving tube makes the instrument very simple to use under the difficult conditions often met with in works practice.

In order to enable the tube to withstand shocks the sensitive thermo-couple is mounted on a spring bracket; thus jarring will not disturb the adjustment of the focussing. The connection of the thermo-couple with the indicating milli-voltmeter is made through a length of flexible cable and a concentric connector, the latter avoiding the possibility of losing a reading from reversed connections. The efficiency of the heat concentration and the high electro-motive force of the thermo-couple make it possible to use a very robust indicating milli-voltmeter. The coil has a double pivotted movement that requires neither levelling in use nor locking when carried. The scale and pointer are both bold, so that they can be easily read in a poor light. As already explained the current flowing through the milli-voltmeter may be made a direct measure of the temperature of the hot body at which the receiving tube is pointed; in practice therefore, the scale is direct-reading; that is to say, the user reads, not current, but hot body temperature.

Fig. 2 shows the pyrometer in use with a hand-guard on the receiving tube. For some work, as for instance, the temperature on top of the bath in an open-hearth furnace, it is inconvenient to hold the tube in the hand and a collapsible tripod is used. Fig. 3 shows the arrangement, also a carrying case which takes the whole outfit.

This instrument may be used to measure the temperature of molten iron as it flows from the furnace. The tube is pointed at the stream, choosing a point where the surface is clean and free from oxide and slag, thus securing steady conditions of measurement.

In the case of the Bessemer converter some little fixing is needed to make the measurement, as it is difficult to come near the converter in action. The tub is fixed so that it measures the heat on the inside of the lining as the converter is tipped to discharge the metal at the end of the blow. This lining temperature is practically that of the metal at this stage.

The open-hearth furnace can be thoroughly explored, temperatures being measured from the roof, walls and top of bath through any of the inspection or charging ports. The stream at tapping may also be measured in the same way as in the case of the blast furnace. The tripod will be needed in both these cases.

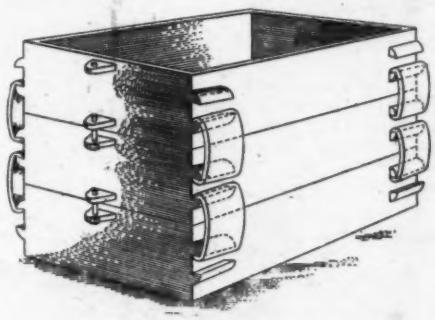
It is fairly well known that different materials have different radiation efficiencies depending on their surface condition. For instance, the clean surface of molten iron or steel gives out much less energy than a surface of slag or oxide. This consideration offers no practical difficulty for the following reasons. In the first place, if the hot body is inside a furnace or other heated enclosure the radiation it gives out is independent of the nature of its surface; it is what is known technically as a "black body." Since the majority of measurements are made in furnaces the ordinary calibrations of the Foster fixed-focus pyrometer are made for such "black bodies."

Where the hot body is out in the open, such as the molten stream or iron or the oxide surface on a billet, it is easy to secure constant conditions of surface, and the pyrometer is then calibrated to read direct without correction under these conditions. In the stream of molten steel the surface will always be clean close to the spout or bar.

A New Moulder's Flask.

A new moulder's flask, recently patented by Mr. L. J. Kreutzberg, U.S.A., is shown herewith. The principal features are the use of any number of copes, which are fastened together to form practically a single unit, and a novel method of fastening so that the several parts of the flask can be fastened or unfastened quickly. In addition to the use of a sectional cope, a series of lugs are permanently attached to the cope and the drag of the flask to receive handles for lifting these parts or for transporting them.

The flask is provided with the usual end lugs for



New Type of Moulder's Flask.

the insertion of steel guide pins, which are threaded and secured by nuts. The sections composing the flask are identical and can be assembled by clamps which engage lugs on the adjacent sides of contiguous sections. The exterior surfaces of the lugs are curved, while the internal faces are flat, inclining toward each other and tapering off toward one end. The clamps resemble a capital C in shape and have tapered clamping faces to correspond with the lugs. In this way it is possible to assemble any number of sections to give the desired depth of cope or drag.

The illustration shows a three-section flask, and the construction of the lugs and clamps is clearly indicated. If desired the two lugs on one corner of each section can also be used as a socket, in which a specially designed handle may be fitted. After the mould has been set up the handles may be withdrawn from the lugs, an arrangement which renders the flask less apt to be disturbed, since there are no projecting arms.

This design of flask is intended to be made of either iron or steel, but the principles embodied in its construction can nevertheless be applied to wood flasks. In this case the lugs on the ends and the sides, the pins, the clamps and the handles can be furnished separately. The use of the lugs on the sides enables long handles to be employed in foundries where heavy work has to be handled and cranes are not available.

An Automatic Ventilating Shutter.

Messrs. Frederick Braby & Company, Limited, Petershill Road, Glasgow, have introduced an interesting innovation in connection with their now well-known "putty-less" skylight, which should be very generally appreciated as it renders ventilation possible without the necessity of lifting a heavy glazed frame, and obviates the risk of breakage incidental to such lifting, apart from the further risk of damage by storm, whilst with the new principle no pulley or quadrant is required. The system may be adapted to suit any form of roof, either corrugated or slate, and flat or curved.

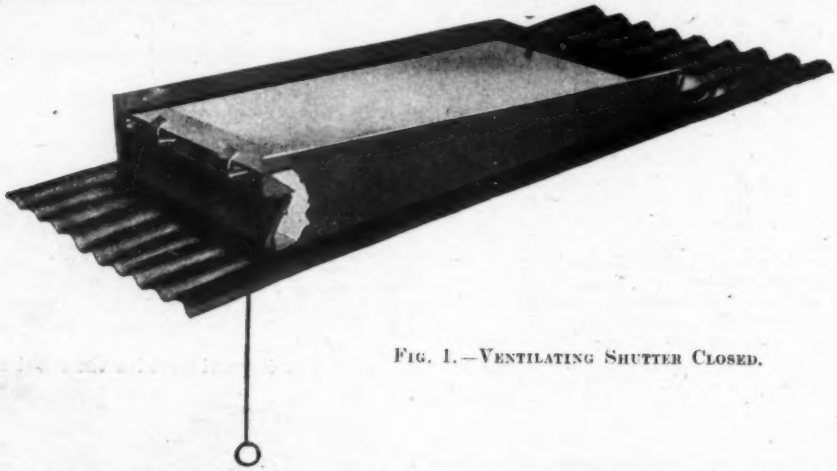


FIG. 1.—VENTILATING SHUTTER CLOSED.

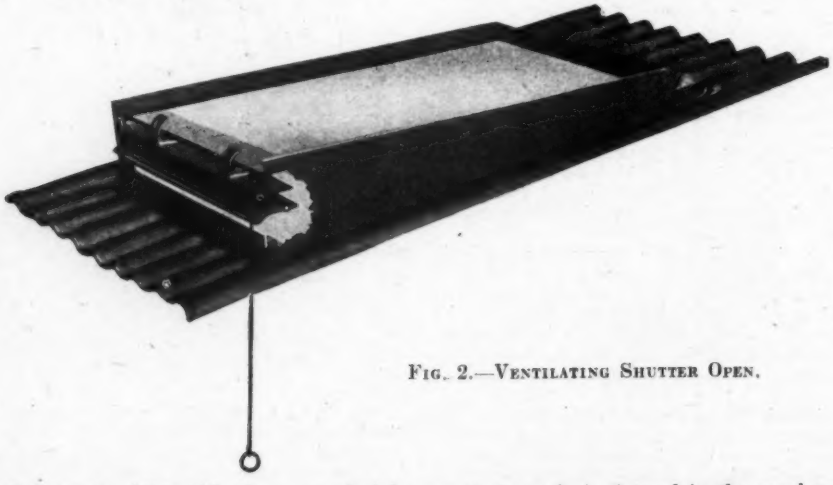


FIG. 2.—VENTILATING SHUTTER OPEN.

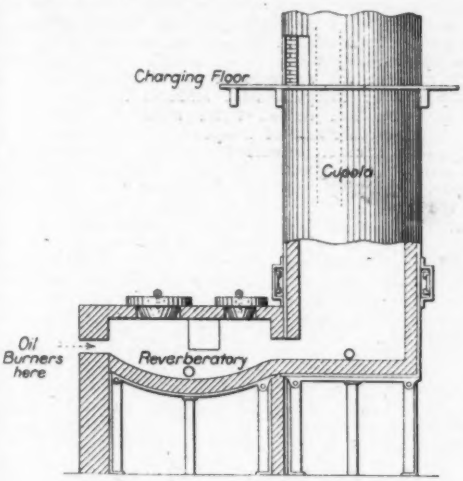
The principle of the Eclipse "Autovent," as it is called, will be understood from our illustrations. It consists in the adaptation of a movable louvre to the ordinary dead light, giving such light all the advantages of an ordinary opening light, but at a much lower cost. The ventilating arrangement is manipulated by a simple cord, the lower end of the louvre being weighted the shutter closes itself immediately the cord is released. If required additional side shutters can be fitted.

Combined Cupola and Air Furnace.

A combination of the reverberatory or horizontal air furnace and the ordinary vertical cupola is in use at the foundry of the Holland-Domschke Foundry Company, Brooklyn, N.Y., U.S.A. The combination has been patented by Mr. T. Holland, President of the company. The accompanying sketch shows the arrangement and mode of operation of the Holland cupola. As used at the Holland-Domschke plant, the vertical cupola is charged in the usual way and part of the iron may be drawn from the cupola, leaving the remainder to flow into the reverberatory or air furnace. Oil fuel is used in the latter and, of course, a close degree of control may be had over the oil-

burning flame in the heating and purification of molten metal in the reverberatory. Into the molten mass in the latter furnace the finely-divided particles of metal, such as filings, borings and turnings are added, the melting of such material in the cupola being impossible.

The heated gases from the reverberatory are conducted to the cupola, as shown, which makes for the maximum utilisation of the heat generated. It has also been found that the use of fine steel scrap has produced a soft steel from the reverberatory furnace. The slag from the cupola passes into the reverberatory on top of the molten iron, and the purifying effect of the floating slag is regarded as a highly satisfactory feature of the operation.



COMBINED AIR FURNACE AND CUPOLA.

Arrangements can be made for using other forms of fuel than oil for the reverberatory furnace and the blast can be preheated slightly by so locating the air pipes that they absorb heat from the furnace. The large reservoir for hot metal created by the combined floor of the cupola and the reverberatory furnace greatly reduces the danger of overflow, and allows for satisfactory control of the slag. The charging of the fine material takes place at the top of the reverberatory furnace. Downward application of the heat and blast is, of course, counted on to bring the small particles into a mass and protect them from the oxidising action of the blast. The possibilities of this furnace for handling such materials as borings and turnings is an interesting feature, quite apart from the refining possibilities of the apparatus.

A Thermit Weld.

The annexed photogravures illustrate an interesting piece of repair work carried out by the Thermit welding process on a fan casing from a colliery. The casing was of cast iron and weighed about 15 cwts., its value being estimated at about £20. As shown in Fig. 1, half the upper flange was broken off, the diameter being 17½ in. and the thickness 1 in. The repair was effected by using the broken part as a pattern, and welding on a new half-flange composed of Thermit metal, using about 65 lbs. of compound. The metal of the casting was soft and ductile, which minimised the risk of fracture during contraction. The casting had previously been repaired by means

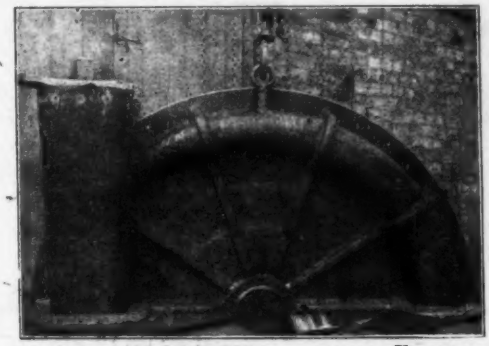


FIG. 1.—A THERMIT WELD, SHOWING FRACTURE.

of a copper liner, and a wrought-iron ring shrunk on around the flange. The repair, which is shown completed in Fig. 2, was put in hand on receipt of

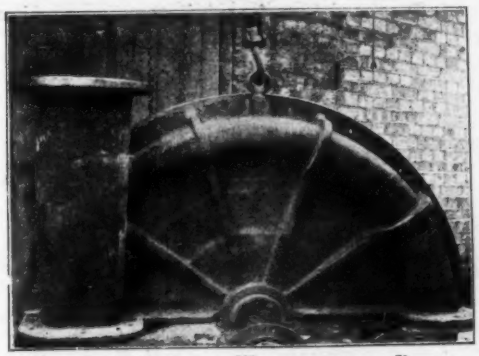


FIG. 2.—A THERMIT WELD, SHOWING REPAIR COMPLETED.

the casting, and the latter was returned to the owners within three days.

Queries.

Preservation of Iron Patterns from Corrosion.

Can any reader tell us of a preparation to use on iron patterns to prevent corrosion? We are at present using paraffin, but find that it dries off in a short time, and the patterns rust very badly. We would be glad to know of anyone who has had experience in using nitric acid for the above purpose.

"W. E. N."

Barrel Cores for Lamp Pillars.

We are making lamp pillars 4 in. diameter at one end and about 11 in. at the other. What method is there of enlarging the core barrel? What is the general procedure for this class of work, and what kind of sand is used? Any hints on barrel-core making would be appreciated.

"A. C."

Inventions.

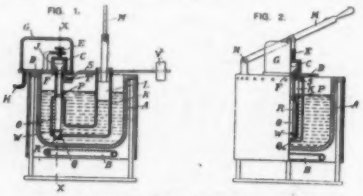
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

20,890. Furnaces. R. C. Royston.
20,913.*Metallurgy of zinc. C. V. Thierry.
20,957. Sand-papering, emery grinding, and analogous machines. D. J. Jarvis.
20,969. Castings of tool-steel. A. L. Van Den Kerckhove, A. Perier, P. Venail, P. C. M. Grenier, and J. E. Jansson.
21,014.*Metallurgy of zinc. C. V. Thierry.
21,034. Moulding-machines. S. Strettles.
21,035. Pattern-drawing machine. S. Strettles.
21,057. Furnaces. E. W. Smith.
21,166.*Delivery pipe for casting-apparatus. F. de Buigné.
21,167.*Process and apparatus for casting metals.
21,282. Making iron moulds or chills for the manufacture of metallic bedsteads, etc. G. A. Phillips.
21,288. Pressure casting machine. W. Mann.
21,522. Treatment of iron and the manufacture of steel. W. H. Butlin.
21,596. Moulding machines for foundry use. J. B. Neesham.
21,604. Guard and fence for spindle-moulding machines. B. Gelman.
21,761. Metallurgical processes. H. C. Woltereck.
21,958. Grinding-machines. A. Berridge and R. R. Powlesland.
22,290 and 22,291. Moulds for casting. J. Shanks.
22,292. Making metal or alloy castings. J. Shanks.
22,786.*Continuous annealing furnace. C. Kugel.
22,918.*Chaplets for metal casting. H. Heesemann.
23,104. Moulding-boxes and pattern-plates. A. C. Nicholson.

Abstracts of British Patent Specifications recently accepted.

26,751 (1910). *Metal-casting Machines.* E. I. Everett, Collindale Works, The Hyde, Hendon, London, N.W.—Fig. 1 is a transverse vertical section of one form of apparatus; Fig. 2 is a half-side elevation and half-section taken on the line X, X, Fig. 1. A is the melting pot; B is a gas ring for heating same; C is the mould shown clamped on a plate D by a clamping screw E, the mouth of the mould being at the bottom in line with an opening F in the plate D; G is a bell enclosing the mould. The bell is, by a suitable suction apparatus, exhausted of air through a pipe H, and a partial vacuum is thus maintained round the mould. The mould is divided horizontally or vertically, as may be desired, and has small channels J formed in the joining faces of the separate parts so as to form communications between the interior of the mould and the space within the bell G. Within the melting pot, is a pump cylinder K, the outlet from which communicates with the opening F in the plate D. The pump plunger L is shown, by way of example, operated through a handle M, pivoted at N to the pot, and having a pivotal connection with the pump plunger. In combination with the pump there is arranged a valve O adapted, when moved in one direction, to bear on a valve seat P and close the channel leading to the mould, and when moved in the other direction to close the opening Q, which forms the inlet for the molten metal entering the pump chamber. The valve O is raised and maintained normally against the seat P by a stirrup piece R, which passes underneath the lower end of the valve spindle, and is suspended from one end of a lever S, which is fulcrummed at T, and loaded with an adjustable weight V. The valve spindle is further constructed with a shoulder at W near its lower end.



Everett's Metal-casting Machine.

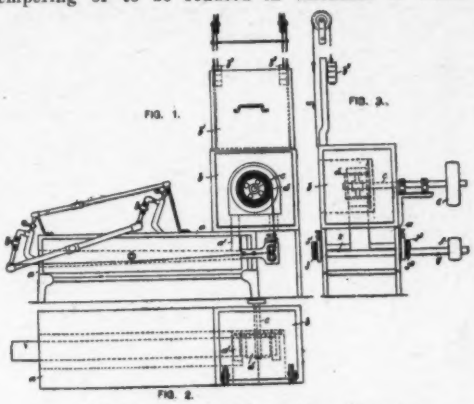
22,660 (1910). *Process for Treating or Renovating Foundry Sand.* Andrew Poulson, Hope House, Farnworth, Widnes.—In the present invention the sand is treated with a mixture of sulphate of alumina and water alone, or in combination with gelatinous silica, or the sand may be treated with aluminoferric cake, and with, or without, the addition of silicate of soda. Commercial sulphate of alumina, or other soluble compound or compounds of alumina, is taken and ground in the dry state to a fine powder, which is then mixed with the spent sand, water being added to the mixture as required; or the sulphate of alumina or other soluble compound or compounds of alumina may be used in lump form, and heated water added to dissolve the sulphate or other soluble compound or compounds, or the sulphate or other soluble compound or compounds of alumina may be ground and mixed with water to form a paste or liquid, such paste or liquid being then added to the sand. Either of these processes has the effect of renovating the sand and making it suitable for iron and steel moulding or core purposes. While both of the foregoing processes are suitable, the inventor prefers to renovate the sand by treating it with a solution of sulphate of alumina in the following manner. A solution of sulphate of alumina is made in the proportion of about 1 lb. of sulphate of alumina to 12 lbs. of water, 160 lbs. of this solution being used per ton of spent sand for moulding purposes, while for cores and dry sand work, more of the sulphate of alumina solution per ton of sand would be desirable. To get a better consistency in the sand for moulding and core making, the sulphate of alumina treatment, as just described, is preferably employed in combination with gelatinous silica. Equal parts by weight of the sulphate of alumina solution, as above, and of gelatinous silica, are taken to form a mixture which is added to the sand in the proportion of, say, 160 lbs. of the mixture of the solution of sulphate of alumina and gelatinous silica to every ton of sand to be treated. For the making of cores and for dry-sand moulding, the treatment of the spent sand, by means of a simple solution of sulphate of alumina, is preferable, while for the renovation of green sand it is preferred to use the combined treatment by means of sulphate of alumina solution and gelatinous silica.

20,509 (1910). *Method of Supplying Air to Compressors for Blast Furnaces, Converters, etc.*—J. Bronn, Varstadtstrasse 10A, Rombach, Germany; and R. Hüttenwerke, Rombach, Germany.—This invention relates to a method of supplying air to compressors for blast furnaces, converters, etc., which air is admitted either directly or after it is dried by means of suitable drying substances or by removing the dampness by a freezing process. The invention is based on the discovery that in iron and steel-making plants the air is considerably cooler and drier at a height of from 25 to 60 meters above the ground than would be expected according to meteorological science. Observations have shown that the difference in the temperatures of the air above and below is not more than 0.2 degrees C., and the difference in the humidity not more than 0.5 grammes per cubic metre. On an average, the temperatures on the tower observed during 12 years were 0.03 degrees C. higher, and the humidity was 0.02 grammes per cubic meter less than the values near the ground. The patentees have discovered that the conditions are entirely different in iron and steel-making plants, where they have made comparative observations at a height of 1.5 meters above the ground and on a tower of a height of 30 metres. The measurements were taken at the same time every morning and evening, and it was found that on a tower 30 metres high the air contained on an average about 25 per cent. less

humidity than near the ground. For example, 1 cubic metre of air which is saturated with water contains at a temperature of 35 degrees C. 42 grammes of water, 30 degrees C. 31.5 grammes of water, 25 degrees C. 23.5 grammes of water, 20 degrees C. 17.4 grammes of water, 15 degrees C. 12.7 grammes of water, 10 degrees C. 9.2 grammes of water, 5 degrees C. 6.6 grammes of water. Therefore, in order to supply dry air for compressors, high vertical tubes, for example, as chimneys, must be passed through the wet atmosphere immediately enclosing the steel-making plant. According to experiments, chimneys of from 25 to 40 metres, or, if possible, of about 60 metres, give satisfactory results.

28,746 (1910). *Manufacture of Iron and Steel.* A. Boucher, Prilly, Canton Vaud, Switzerland.—This invention relates to a process of electrolytic refining of cast iron, which produces directly pure iron of constant composition, and consists in the use of cast iron as an anode, the electrolyte being maintained in the ferrous state by its contact, outside the electrolytic vat, with masses of iron having a large contact surface in the form of turnings or scrap iron, for instance, any solid substances in suspension in the electrolyte being excluded from the electrolytic vat. The anode or anodes are constituted by cast-iron pigs or pieces of cast iron of any shape. The cathode is constituted by a substance which is a conductor of electricity. It is on the cathode that iron is deposited. This cathode is preferably mounted so as to be able to rotate about its axis in the known manner, but instead of moving the cathode, it might be left stationary, and the anodes moved. The electrolyte is constituted by a solution of ferrous salts, for instance, ferrous chloride or sulphate, or a mixture of these two salts. The current used is a high density current, that is to say, having a great intensity relatively to the surface of the electrodes. It is easily possible to use 1,000 amperes per square meter, and in certain cases this amperage can be still further increased. Currents of less high density could also be used, without any other disadvantage than that of reducing the quantity of metal deposited in an apparatus in a given time. On the electrolytic cell is branched a pipe which enables the electrolyte to circulate and brings it into a vessel containing divided iron, for instance, iron turnings. The electrolyte circulates, therefore, through the electrolytic vat for passing from there to the divided iron, before again returning to the vat, and thus solid particles in suspension in the electrolyte are excluded. If in the conditions described electric current is caused to circulate, the iron contained in the anodes of cast iron will pass, as the reaction proceeds, to the conducting cathode. During the operation the ferrous salt employed has a tendency to become converted into ferric salt, to the detriment of the iron deposited on the cathode. If this transformation were allowed to take place, the deposit of iron on the cathode would not possess any homogeneous nature, and would become spongy. In order to prevent such an occurrence, the derivation or branch outside the electrolytic vat is provided, in order that the ferrous salt should be always in contact with an excess of pure iron, so as to prevent its transformation into ferric salt and to bring back to the state of ferrous salt any ferric salt that may be formed.

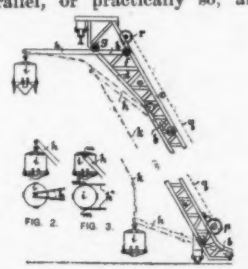
4,753 (1911). *Gas-heated Metalworking Furnaces.* Fletcher Russell & Company, Limited, and T. W. Fletcher, Palatine Works, Warrington.—Fig. 1 is a side view, Fig. 2 a plan and Fig. 3 an end view of the furnace. The invention consists in mounting at one end of an ordinary horizontal gas-heated furnace, as *a*, a case or chamber as *b*, that is heated by the hot air from the furnace *a* passing into the chamber through the flue a^1, the chamber being closed when required by means of a sliding door b^1, which is balanced by weights b^2. The door is shown in the drawing in the open position in order to obtain a view of the interior. Fitted transversely in the centre of the chamber *b* is a shaft *c*, and a pulley *d* is fitted on the inner end of the shaft, the opposite end of the shaft extending through and beyond the back of the chamber *b* where it is supported on brackets and carries a pulley *e*. This is connected by a band or strap to a pulley *f* on a shaft *g* with pinions *j* and j^2 that gear respectively into pinions j^1 and j^3, so that the shafts form a pair of guide rollers as *k*, which are below the chamber *b*. A coil of hoop iron, steel tapes or wire that requires tempering or to be reduced in thickness or width is



Gas-heated Metal-working Furnace.

placed on the pulley *d*, where it is heated to any degree, after which it is passed through the furnace *a*, and either drawn through rolls or otherwise treated.

3,546 (1911). *Appliance for Filling Cupola Furnaces.* J. L. T. Groneman, Hengelo, Holland.—Fig. 1 illustrates diagrammatically one construction of the appliance. Figs. 2 and 3 show two methods of attaching the bucket to the overhanging arm of the traveller. The framework for supporting and guiding the transporter with its overhanging arm is provided with two tracks *c* and *d*. The traveller *b* runs with one wheel *f* bearing on the underside of the track *c*, and its other wheel *g* on the top of the track *d*. Up to a certain distance from the top of the framework the tracks *c* and *d* are parallel, or practically so, and guide the



Appliance for Filling Cupola Furnaces.

traveller *b* in such a manner that the overhanging arm *h* points steeply upwards. Near the top of their course, however, the track *d* diverges inwards away from the track *c*, whereby the arm of the traveller towards the end of its upward travel assumes an almost horizontal position. This guiding of the arm and traveller has the result that the free end of the arm *h* carrying the filling bucket moves upwards in the path shown in Fig. 1 by the chain dotted line *k*. The bucket *i* may be suspended from a hook at the end of the overhanging arm *h* as shown in Figs. 1 and 2. An alternative method of connection is to provide the arm *h* with a forked end, the limbs of which are connected to the bucket by means of two pivot pins *m*. This construction somewhat reduces the height of the appliance, whereby the filling opening of the furnace may be made somewhat lower. The framework *a* may be made fixed or pivoted as in a rotary crane, or may also be made to run on rails. The movement of the traveller may be produced by windlass *p*, and rope or chain *q*, passing over a wheel *r*, and effecting the raising or lowering of the traveller.

Trade Talk.

THE UNION ENGINEERING COMPANY, Wood Street, Liversey Fold, Darwen, are relinquishing their business.

MESSRS. S. BILL & COMPANY, engineers, have removed from 54, Guest Street, to 387, Park Road, Hockley, Birmingham.

MESSRS. PARKER & HAEGERTY, metal merchants and agents, have removed to 6 and 8, Lime Street Square, London, E.C.

THE Glasgow and West of Scotland Technical College, Glasgow, will in future be known as the Technical College, Glasgow.

SPERRYN & COMPANY, LIMITED, brassfounders, Hospital Street, Birmingham, have removed to Moorsom Street, Birmingham.

THE NORTH BRITISH LIFTING & MOVING APPLIANCE COMPANY, LIMITED, have removed from 56 to 77, Robertson Street, Glasgow.

MR. L. H. FRY, 34, Victoria Street, London, S.W., has been appointed European representative of the Baldwin Locomotive Works.

BROTHERTON TUBES AND CONDUITS, LIMITED, have removed their stores from Bennett's Yard, Marsham Street, S.W., to Brewer's Green Yard, Victoria Street, London, S.W.

A RECEIVING order has been made in connection with the affairs of Messrs. A. E. Taylor and A. Hunter, trading as Taylor & Hunter, ironfounders, North Road Foundry, Norby, Thirsk.

THE Dud Dudley Memorial in St. Helen's Church, Worcester, has been restored by the Staffordshire Iron and Steel Institute, and was unveiled on October 7 by the President of the Institute.

MR. J. MAYER, of Hillside, Muirend, Cathcart, Glasgow, has been appointed sole agent in Scotland for Messrs E. G. Appleby & Company, 10, Victoria Street, Westminster, London, S.W.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, of Glasgow, have received an order to construct fourteen express locomotive engines and tenders for the Buenos Aires Pacific Railway Company.

AN outbreak of fire on October 7 last destroyed the engineering shops at the Mossend Steel Works, Mossend, belonging to William Beardmore & Company, Limited The damage was very heavy.

ROE & HARRISON, LIMITED, of the Globe Foundry, Derby, have appointed Mr. T. S. Smith, of 5, Idol Lane, Eastcheap, London, E.C., as sole agent for the sale of their castings in London and district.

HASLAM & SCHONTHEIL, LIMITED, 11, Windsor Place, Cardiff, have been appointed selling agents in South Wales and Monmouthshire for Edward Bennis & Company, Limited, Little Hulton, Bolton.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, are building a new foundry at their works at Rugby. They are removing their Leeds office from Greek Street Chambers to Standard Buildings, City Square.

MR. J. T. LOWKE, engineer and brassfounder, 18, Kingswell Street, Northampton, has acquired the goodwill, patterns, etc., of Messrs. Grose, Norman & Company, engineers, Reliance Works, Northampton.

E. BROOK, LIMITED, engineers, of Coln Road, Huddersfield, have appointed Mr. C. H. Jessop as their representative for London and the South, with offices at 163, King Street, Hammersmith, London, W.

MR. J. NEILSON, 90, Mitchell Street, Glasgow, has been appointed agent in Scotland and Ireland for the sale of the steel manufactures of the Skinningrove Iron Company, Limited, Carlin How, R.S.O., Yorkshire.

MESSRS. BACHE BROTHERS, edge tool makers, of the Stakenbridge and Churchill Forges, Churchill, near Kidderminster, have turned their business into a private limited concern, under the style of Bache Brothers, Limited.

THE HARLESTON WORKS, SHEFFIELD, of Moorwood, Sons & Company, Limited, ironfounders and engineers, together with the plant and machinery were sold by auction recently by order of the High Court. The price realised was £18,200.

MR. F. C. HEMMENS has been appointed by the Summerford Iron Company, Limited, of Falkirk, as their agent in the South and West of England and South Wales. Mr. S. Heeps has been appointed the company's agent in Ireland and Scotland.

MESSRS. O'BRIEN, THOMAS & COMPANY, iron merchants, White Lion Wharf, 17, Upper Thames Street, London, E.C., have acquired the businesses of Yates, Haywood & Company and the Rotherham Foundry Company, Limited, and W. G. Skelton, Corbitt & Company, Limited.

THE first meeting of the present session of the Staffordshire Metallurgical Old Boys' Association, was held at Wednesbury recently. Mr. J. J. Thomas, the retiring president, occupied the chair, and the new president, Mr. H. H. Waldron, gave his presidential address on the "Treatment of Steel."

MR. F. W. BRIDGES is organising an international exhibition of metals other than iron and steel, which is receiving the active support of Sir Gerard A. Muntz, president of the Institute of Metals. The exhibition will be open at the Royal Agricultural Hall, Islington, from May 6 to 18, 1912.

MR. C. J. MUNRO, 50, Frederick Street, Edinburgh, has been elected trustee of the estate of John Kirkwood, ironfounder, trading as James Kirkwood, The Foundry, Tranent. Creditors must lodge their claims by November 23, and they meet at the Sheriff Court House, Haddington, on December 14.

A MEETING of the members of the Aluminium Corporation, Limited (1907), will be held at 60, London Wall, London, E.C., on Wednesday, December 6, for the purpose of having an account laid before them, showing the manner in which the winding-up has been conducted and the property of the company disposed of.

MR. ARTHUR BALFOUR, managing directeor of Seebohm and Dickstahl, Limited, of the Dannemora Steel Works, Whitley Street, Sheffield, was installed as Master Cutler of Sheffield at the Court House, last month, by the retiring Master, Mr. George Senior, of George Senior & Sons, Limited, Ponds Forge, Sheaf Street, Sheffield.

A COMMUNICATION has been received from the Stamp End Works, Lincoln, of the firm of Clayton & Shuttleworth, Limited, stating that the directors, after long negotiations, had received an offer from a powerful Austrian syndicate to purchase the property of the company in Austria-Hungary, Roumania, and Bulgaria.

LANCASTER & TONGE, LIMITED, of the Lancaster Works, Pendleton, Manchester, have secured an order from the Commonwealth Portland Cement Company, Sydney, New South Wales, for piston rods, cast-iron junk cover pistons, complete with rings and coil, duplex and single metallic packings, piston rings and serpent coil as spares, etc.

MOSES EADON & SONS, LIMITED, of the President Steelworks, Sheffield, inform us that Mr. J. Barton (agent) has been transferred from the North-Eastern and the North-Western districts to South Wales and the West of England. Mr. W. H. Parker, agent for Scotland and Ireland, will take over Mr. Barton's previous districts.

THE NORTON HARTY ENGINEERING COMPANY are making considerable extensions to their Central Works, Great Bridge, Tipton, Staffs., where they have just taken out the foundations for the erection of three additional bays, each 120 ft. by 30 ft. One of these will be utilised for extending the machine and fitting shop, and two for the constructional department.

W. T. FLATHER, LIMITED, crucible steel makers, whose business was established in 1817, have occupied the Standard Steel Works at Sheffield for 50 years. This jubilee was celebrated on October 14, when the whole of the staff were taken into Derbyshire, and afterwards entertained to dinner at the Masonic Hall at Sheffield. A silver rose bowl was subsequently presented to each director in commemoration of the jubilee.

THE BILSTON FOUNDRY, Bilston, South Staffs., belonging to Mr. Thos. Holcroft, was under the hammer of Mr. D. J. Shedden, for dismantling purposes, on October 13. The sale was largely attended, and for the most part good prices were realised. The lots included the ironfoundry and engineering plant, comprising cupolas, air furnaces, Root's blowers, blast mains, cranes, roll lathe and gear, 36-in. facing lathe on 20-ft. bed, about 250 tons of roll boxes and box-parts, about 50 tons of roll, nose, helve, and lifter chills, 150 tons of core bars, plates, etc., five foundry lathes, three electric motors, and general effects.

AT the London Bankruptcy Buildings, on October 24, meetings of creditors and contributories were held in the liquidation of G. Aston & Sons, Limited, constructional engineers and ironfounders, 46, Eagle Wharf Road, London, N., under a winding-up order made on July 11 upon a creditor's petition. A statement of the company's affairs disclosed as regarded creditors total liabilities amounting to £97,897 10s. 5d., of which £64,230 2s. 11d. represented loans on debenture bonds and interest. The whole of the assets, estimated at £37,233 8s. 9d., were required to meet these debentures, and the deficiency of assets to meet liabilities amounted to £38,613 10s. 11d. With regard to contributories, an additional deficiency of £55,696 16s. was disclosed, making a total deficiency of £94,310 6s. 11d.

THE annual meeting of the Birmingham Metallurgical Sceiety was held last month, at the Municipal Technical School, Birmingham, Professor Stansbie presiding over a good attendance. The annual report stated that last year's work included four joint meetings with other societies, which were so successful that further similar meetings had been arranged during the coming session. The total income was £52 2s. 6d., and after meeting all expenses there was a balance in hand of £6. An excellent programme of lectures and papers had been arranged for the coming session, including a series of three biographical lectures on the work of famous metallurgists. The report was adopted. Professor J. H. Stansbie, B.Sc., F.I.C., was unanimously elected president, Messrs. S. F. Hopkins, I. Lester, and Henry Rogers, vice-presidents, and Mr. H. Rogers treasurer. Mr. W. J. Rees retired from the secretaryship, and was elected editorial secretary, Mr. H. J. Jacks, who had been joint secretary, becoming general secretary, with Mr. H. Sewell as financial secretary. The committee were chosen as follows:—Messrs. T. C. Humphreys, A. Spittle, E. R. Shotton, W. Strange, H. H. Cooke, F. C. Lantsberry, and S. Lamb.

WE understand that the London Emery Works Company, Park, Tottenham, London, N., have booked orders during September last for the following foundry plant and machinery:—One hydraulic moulding machine plant, comprising pump, accumulator, and "boxless" moulding machine for making colliery tub wheels up to 16 in. on the flange, and also a sand sifting and mixing machinery, for Scotland; a hydraulic turnover moulding machine for boxes 40 in. by 20 in., also a hand-ramming stripping plate machine, for gear wheels, to be shipped to South America; a sand-mixing and sand-blast tumbling barrel plant, for a new steel foundry in the North of England; a hydraulic moulding machine plant, comprising one turnover moulding machine for making plough points, one turnover moulding machine for dealing with rain-water connections, one "boxless" machine for making brackets, together with hydraulic force pump and accumulator; also a sand mixing machine, for Scotland; a hydraulic moulding machine plant comprising turnover moulding machine, "boxless" moulding machine, and a stripping plate moulding machine for making boiler-furnace bars and fittings, for Lancashire; finally, one hand-ramming turnover moulding machine with a set of boxes, for dealing with brass casement fittings, for a new foundry in Essex.

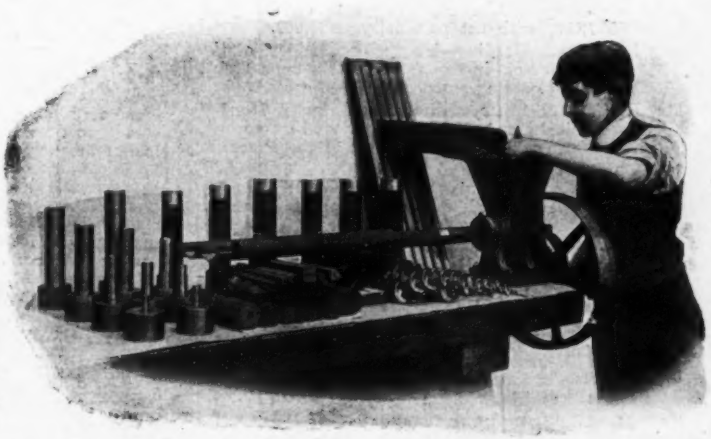
IMPROVED CORE MACHINES.

ROTARY TYPE–
Two feet of perfect core in 10 seconds.
Improved worms.
Cheap mixtures
Excellent results.

PISTON TYPE–
Recommended for large sizes.
Ordinary sand.
Dead length.

Round, square, oval, oblong and other sections on either machine.

Spare dies worms, etc., supplied from stock for other makes of machines, also intermediate dies in sixteenths.



Adopted by British Admiralty, London County Council, Railway Companies and others throughout the Country and abroad.

HORACE P. MARSHALL & CO., LEEDS.

Personal.

MR. W. T. DUNN has resigned the secretaryship of the Junior Institution of Engineers.

MR. ANDREW CARNEGIE has been nominated for the Lord Rectorship of Aberdeen University.

SIR WILLIAM STEPHENSON is to be invited to accept the Mayoralty of Newcastle-on-Tyne for the seventh time.

MR. T. L. AVELING, joint managing director of Aveling & Porter, Limited, has been made a J.P. for Rochester.

MR. J. W. HORNSBY, of Richard Hornsby & Sons, Limited, Grantham, has accepted an invitation to be Mayor of Grantham

MR. WM. BECKETT, of 118, Queen Street, Glasgow, has been elected a director of the Glenboig Union Fireclay Company, Limited.

MR. A. GAUNT, of Pollock & Macnab, Limited, of the Britannia Machine Tool Works, of Bredbury, Manchester, was recently married.

THE gross value of the estate of the late Mr. Richard Scholefield, engineer and ironfounder, of the Burley Vale Mills, Leeds, is £33,329.

SIR JOHN RANDLES has been adopted as prospective Conservative candidate for North-West Manchester in opposition to Sir George Kemp.

H.R.H. THE DUKE OF CONNAUGHT, K.G., has accepted the Presidency of the Northampton Polytechnic Institute, Clerkenwell, London, E.C.

MR. D. G. PARKS, of Messrs. Sergeant & Parks, lead merchants, Maidstone, will be Mayor of that borough during the ensuing twelve months.

THE late Mr. E. Snowball, engineer, Glasgow, late of the North British Locomotive Company's works, left personal estate valued at £15,045.

MR. J. ROWE, J.P., manager of the business of E. Finch & Company, Limited, Bridge Works, Chepstow, has resigned after 54 years' service with the firm.

MR. E. R. WIKELEY, a short time back with Sybry, Searls & Company, Limited, has been elected a director of the Pearlite Steel Company (1910), Limited.

THE late Mr. G. H. Haswell, until lately managing director of Tangyes, Limited, left estate of the gross value of £27,053, with net personalty, £25,662.

THE late Mr. J. Harding, ironworks manager, of the Old Rectory, Norton-in-the-Moors, Stoke-upon-Trent, Staffordshire, left estate valued at £23,843 gross.

MR. R. LUDWIG MOND, a director of Brunner, Mond & Company, Limited, and the Mond Nickel Company, Limited, has been added to the Justices of the Peace for Sevenoaks.

MR. G. R. ROSEVERE, works engineer to the Austin Motor Company, Limited, has been appointed works manager to John Musgrave & Sons, Limited, Globe Iron Works, Bolton.

THE late Mr. J. H. Hale, a director of Frederick Braby & Company, Limited, left estate of the gross value of £281,673, of which the net personalty has been sworn at £259,660.

MR. A. J. HOBSON, chairman of Wm. Jessop & Sons, Limited, and J. J. Saville & Company, Limited, and a director of Richard Hornsby & Sons, Limited, is the Lord Mayor-Elect of Sheffield.

MR. M. W. SWINBURNE, Mayor of Wallsend, has accepted the office for another year. Mr. Swinburne is a director of M. W. Swinburne & Sons, Limited, Wallsend Brass Works, Wallsend-on-Tyne.

MR. H. S. TETT, managing director of Henry S. Tett & Company, Limited, iron merchants and engineers, 10, Market Street, Faversham, has been added to the Commission of the Peace for Faversham.

MR. J. M. D. HENDERSON, M.P. for West Aberdeenshire, who is a director of Ferranti, Limited, and Thos. Bolton & Sons, Limited, has been added to the Commission of the Peace for the County of Suffolk.

MR. T. HUNTINGTON has had the honorary degree of Doctor of Engineering conferred upon him, in connection with the inauguration of the Metal Founders' Institute and Technical High School at Breslau.

MR. W. R. ELLISON, works manager of Messrs. H. Bessemer & Company's Bolton Works, who is leaving to take up an appointment at Sheffield, has been the recipient of a presentation from the officials and men.

MR. F. W. RAIKES, managing director of Cordes (Dos Works), Limited, Dos Works, Newport, Mon., has been the recipient of a presentation from the officials and men on the occasion of the celebration of his silver wedding.

MR. O. C. MORGAN, assistant works manager at the Parkgate Iron and Steel Works, who has been appointed works manager to H. Bessemer & Company, Limited, Bolton, has been the recipient of a presentation from the officials and men at the Parkgate Works.

MR. PERCY WILSON, of the foundry department at the Riddings Ironworks, of Messrs. Jas. Oakes & Company, who has now been appointed assistant manager at the Staveley Works, has been the recipient of a presentation from the officials and men at Riddings.

THE late Mr. H. M. Kennard, of the Blaenavon Company, Limited, and the Falkirk Iron Company, left estate valued at £124,149 gross, with net personalty £123,642. He appointed his son, Mr. M. T. Kennard, to be a partner in the Falkirk Iron Company, and gave to him all his interest except debenture stock in the Blaenavon Company, Limited.

Legal.

Action against Associated Ironmoulders of Scotland.

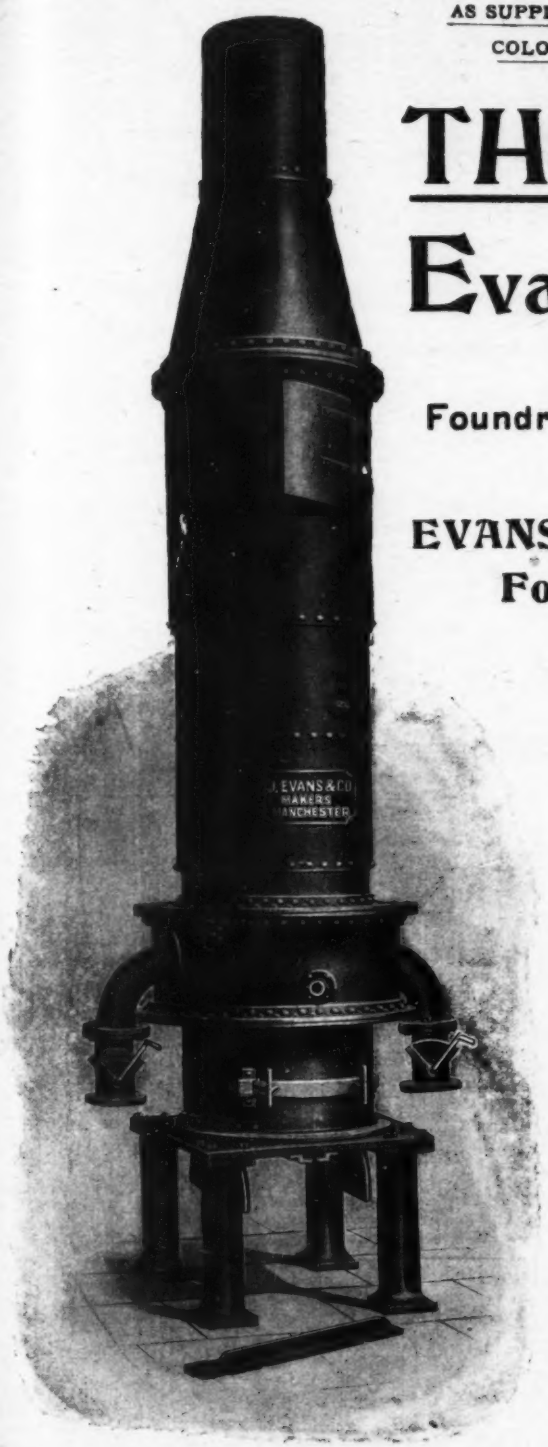
In the Edinburgh Court of Session on October 17, before Lord Skerrington, the record was closed and the pleadings sent to the procedure roll in the action by J. Johnstone, ironmoulder, Glasgow, against the Associated Ironmoulders of Scotland and others, the trustees. Declarator was asked (1) that that part of Rule 20, Subsection 4, of the rules of the Association, which provides "As it is important for the protection of our trade interest that we should have representation in the House of Commons, the Executive shall take such steps as may be deemed necessary to give effect to the principle of labour representation" is *ultra vires* and illegal and invalid, and not binding upon the pursuer or any other member of the Association; and (2) that the Association is not entitled to make payments out of its funds or out of moneys already contributed by or levied from or to be contributed by or levied from its members or branches to the Labour Party or for the payment of Parliamentary election expenses or for any purpose whatever in furtherance of securing or maintaining Parliamentary representation, and that such payments were *ultra vires* of the Association and were illegal. Interdict was also asked. The defenders pleaded that the action was excluded by the arbitration provisions in the rules, and that the pursuer having bound himself to refer all questions between him and the Association to arbitration, and the question at issue being one within the terms of the reference, was barred from taking the present action. Further, they pleaded that, not having proposed or intended to apply any part of the general funds of the Association to the purposes objected by the pursuer, the action was uncalled for. They also held that the action was unnecessary, as they had no intention of making any further Parliamentary levy. They stated that the amount of the levy was fixed by a majority of 1,835 against 407, and that they had taken no steps to enforce the levy against the pursuer.

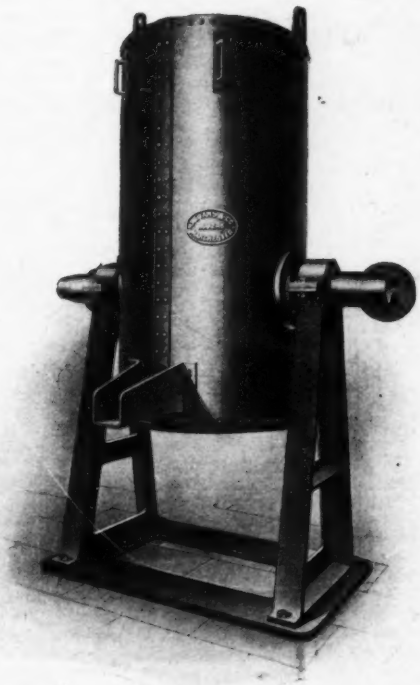
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





Telegrams: "LADLES, MANCHESTER."

James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Deaths.

Mr. W. H. Laycock, recently manager to W. Summerscales & Sons, Limited, of Keighley, died recently, aged 56 years.

Mr. J. Grieve, of Messrs. John Grieve & Company, Motherwell Crane and Engine Works, Motherwell, died recently in his 72nd year.

Mr. D. Keay, Hillbank Ironworks, Dundee, died on October 12. The deceased had carried on business for over half a century, and was widely known.

The death took place recently, at Calne, of Mr. E. Woodward, proprietor of the Biddlestone Ironworks, near Chippenham, Wilts., at the age of 62 years.

The death is announced, at the age of 70 years, of M. Raoul d'Huart, a director of the Société Métallurgique de Senelle-Maubeuge, of Maubeuge, Nord, France.

Mr. J. B. Bruce, who founded the firm of J. B. Bruce, Limited, brassfounders, of Ernest Street, Holloway Head, Birmingham, died recently in his 69th year.

Mr. J. R. Tennear, at one time manager of the Westbury Ironworks, Westbury, Wilts, of the New Westbury Iron Company, Limited, died at his residence, Redland, Bristol, recently, aged 57 years.

Mr. C. L. Hett, of Springfield House, Wrawby, Brigg, died very suddenly on September 22. Many years ago the deceased carried on an extensive business at Brigg as an engineer and iron founder. He was 65 years of age.

The death is announced from Bromley, Kent, of Mr. James Melling, of Dashwood House, 9, New Broad Street, London, E.C., who was the London agent for Joseph Jackman & Company, Limited. He was 63 years of age.

The death took place recently, at Manchester of Sir William J. Crossley, Bart., of Crossley Brothers, Openshaw, Manchester. The deceased baronet, who was born in 1844, was an ex-M.P. for the Altrincham Division of Cheshire.

The death is announced of Mr. W. Souls, who for over 60 years had been associated with the business of John Yates & Company, Limited, edge tool manufacturers, of the Exchange Works, Rocky Lane, Aston, Birmingham. He was 74 years of age.

Mr. J. H. Barber, of Netherfield, Woodhouse, died recently, at the age of 74 years. The deceased gentleman was the managing director of Brown Bayley's Steel Works, Limited, of Attercliffe, Sheffield, with which firm he had been connected for forty years.

The death took place recently at Woodlea, Woldingham, Surrey, of Mr. G. Sonnenthal, one of the founders of Selig, Sonnenthal & Company, now incorporated in the Selson Engineering Company, Limited, of Coventry, of which firm he was chairman. He was 68 years of age.

Mr. James Ferguson, ironfounder, of Tay Street, Tayport, died recently aged seventy years. The deceased and his brother William began business in a small way in 1874, and succeeded in building up a large connection. The partnership was dissolved in 1897, since which time the deceased had carried on the business, the premises being greatly extended and improved.

Mr. C. F. Clark died at his residence, Glen Tower, Avenue Noad, Wolverhampton, on October 15, in his 80th year. Mr. Clark was the last survivor of the gentlemen who founded the firm of T. & C. Clark & Company, Limited, Shakespeare Foundry, Horsley Fields, his previous partner having been his brother-in-law, the late Mr. Samuel Loveridge. The deceased gentleman, some years ago, was a familiar figure at the Birmingham Iron Exchange.

Mr. F. Braby, F.C.S., F.G.S., of Bushey Lodge, Teddington, died at his residence on October 9, aged 82. The deceased was a director of the firm of Frederick Braby & Company, Limited, engineers, iron and metal manufacturers, etc., of the Fitzroy Works, Euston Road, London, N.W., Ida Works, Deptford, London, S.E., the Havelock Works, Litherland, near Liverpool, and the Eclipse Works Glasgow. Mr. Braby had for some time taken no active part in the management of the business.

New Companies.

Harringay Engineering Company, Limited.—Capital £500 in £1 shares.

Winsler Engineering & Clutch Company, Limited.—Capital £2,000 in £1 shares.

John Lewis & Sons, Limited.—Capital £20,000 in £1 shares, to carry on the business of engineers, etc.

S. Briggs & Company, Limited.—Capital £25 in £1 shares (10,000 preference), to carry on the business of engineers.

Thomas W. Cunningham & Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers, etc.

Watson, Foggo & Company, Limited.—Capital £4,000 in £1 shares (750 preference), to carry on the business of engineers, etc.

Alexander Patents Engineering Company, Limited.—Capital £21,000, in £1 shares. Registered office: Alderman's House, E.C.

H. R. Marsden, Limited.—Capital £45,000 in £1 shares, to acquire the business carried on at Soho Foundry, Leeds, as H. R. Marsden.

F. W. Berwick & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 18, Berkeley Street, W.

Thomas Hughes & Company (Salford), Limited.—Capital £200 in £1 shares, to carry on the business of engineers, etc. Registered office: 7, Stanley Street, Salford.

Grampian Engineering and Motor Company, Limited.—Capital £8,000 in £1 shares, to acquire and carry on the existing business. Registered office: Causeway Head, Stirling.

Dashwood & Hamilton, Limited.—Capital £4,000 in £1 shares (1,000 5 per cent. preference), to carry on the business of founders. Registered office: Euston Buildings, George Street, N.W.

British Structural Steel Company, Limited.—Capital £50,000 in £1 shares, to carry on the business of iron founders, mechanical engineers, manufacturers of and constructors of bridges, etc.

British Machine Tool Corporation, Limited.—Capital £30,000 in 120,000 shares of 5s. each, to acquire the patterns, drawings, etc., formerly belonging to the Eclipse Tool Company. Registered office: 54, Gordon Street, Glasgow.

Yarwood & Company (Novelty Ironworks), Limited.—Capital £5,000, to carry on the business of iron founders, mechanical engineers, manufacturers of machinery, etc. Registered office: Novelty Ironworks, Manchester Road, Northwich.

William Grice & Sons, Limited.—Capital £10,000 in £1 shares, to carry on the business of machinists, manufacturers of steam and gas engines, etc., and to adopt an agreement with a company with a similar title, and S. J. Bates, the liquidator.

Chester's Renfrew Engineering Company, Limited.—Capital £60,000 in £1 shares, to carry on the business of founders, engineers, manufacturers of mining, drilling, and other machinery, etc., and to adopt an agreement with Sir Edward F. Coates, A. Ewing, Edward Chester & Company, Limited (in liquidation), and D. F. Basden. Purchase consideration: £66,000, payable in debenture stock, for the acquisition of the business and assets of Edward Chester & Company, Limited.

PURE METALS

and ALLOYS. FREE from CARBON.

TITANIUM THERMIT

for

SOUND, STRONG, CLOSE-GRAINED CASTINGS.

Also FERRO VANADIUM and FERRO TITANIUM.

Full Particulars and PRICES from—

THERMIT LIMITED

Telegrams: "Fulmen, London."
Telephone: 3749 Central,

27, Martins Lane,
Cannon Street, E.C.

Works: 210a, Bow Road, E.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, mor free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

METALS.	End Oct., 1911.	End Oct., 1910.
Iron—Scotch pig warrants ton	*52/3	*55/9
—Middlesbro' warrants . ton	46/6	49/11
—W.C. M/nos Bessemer ... ton	63 6	66 6
—Stock, Scotch ... ..tons	1,000	1,000
Copper—Chili bars, GMB ton	£55 10 0	£56 15 0
—Stock, Europe and afloat tons	61,413	88,422
Tin—English ingots ... ton	£196 0 0	£163 10 0
—Straits ... ... ton	£190 5 0	£165 10 0
—Stock, London, Holland, U.S.A., and afloat ...tons	—	—
Lead—English pig ... ton	16 0 0	£13 12 6
Spelter—Ord. Silesian ... ton	£ —	£24 1 3
Quicksilver (75lb)... bottle	£8 10 0	£8 7 6
Antimony—Regulus ... ton	£28 0 0	£29 10 0–£30 0 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
„ 3 to 4 in.	4 10 0	to	5 0 0
„ 5 to 8 in.	4 7 6	to	4 10 0
„ 10 to 16 in.	4 7 6	to	4 10 0
„ 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)	2 17 6	to	3 0 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 9s. 0d.; light waought, £1 5s. 0d.; heavy cast, £2 6s. 0d.; all per ton, f.o.b., London. Copper (clean), £51 10s. 0d.; brass (clean), £38; lead (usual draft), £14 15s. 0d.; zinc, £20 10s. 0d.; all per ton delivered merchant's yard.

MR. A. E. WOOLSLEY and Mr. L. W. Hoyt, who have been connected with the South Works of the Illinois Steel Company, South Chicago, Ill., have been appointed general and assistant general superintendent respectively of the works of the Tata Iron and Steel Company, Sakchi, Bengal, India. Mr. O. O. Laudig, also formerly of the South Chicago works and more recently of Sault Ste. Marie, Ont., has been appointed superintendent of the Tata Company's blast furnaces.

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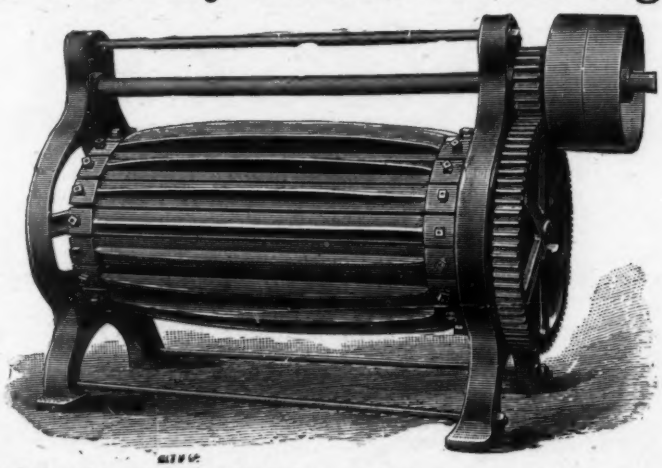

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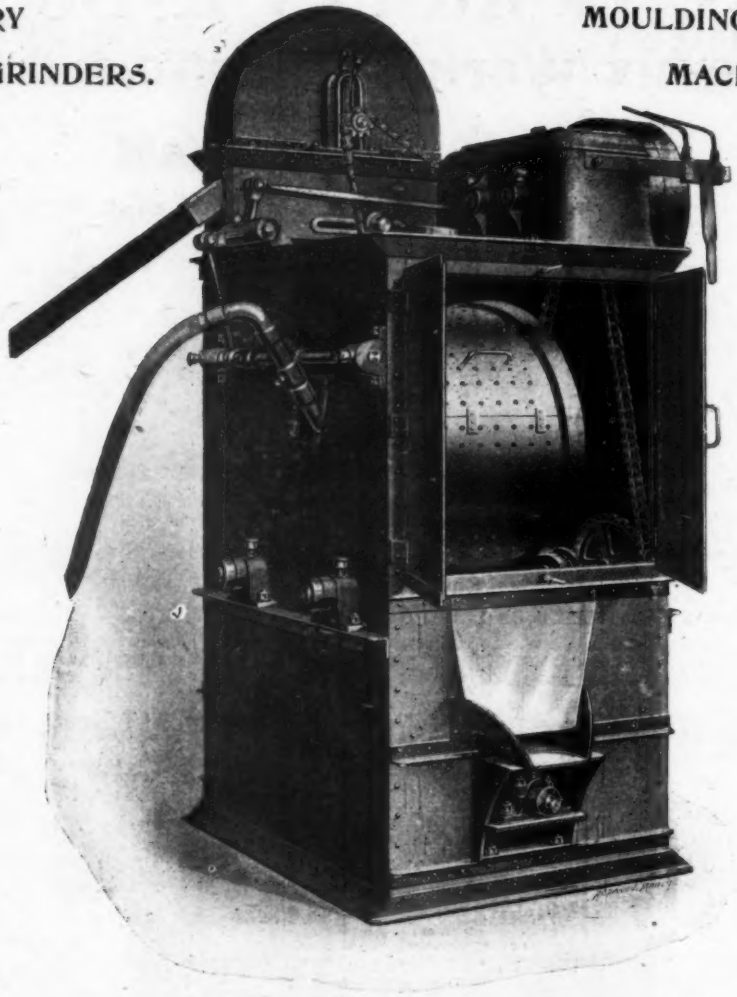

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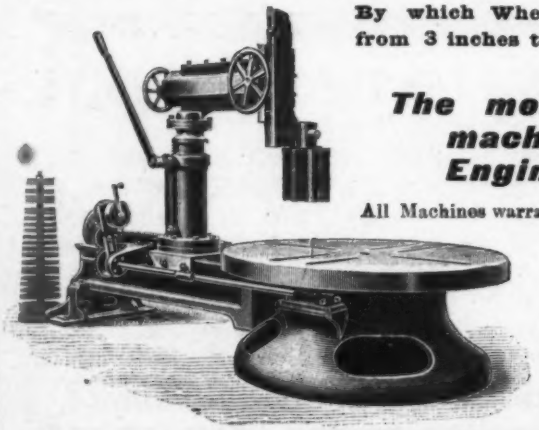

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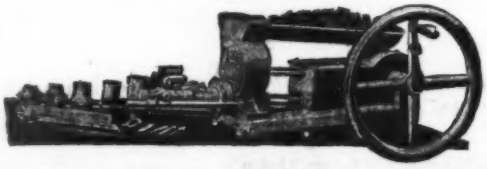

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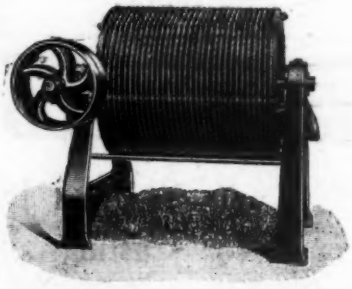

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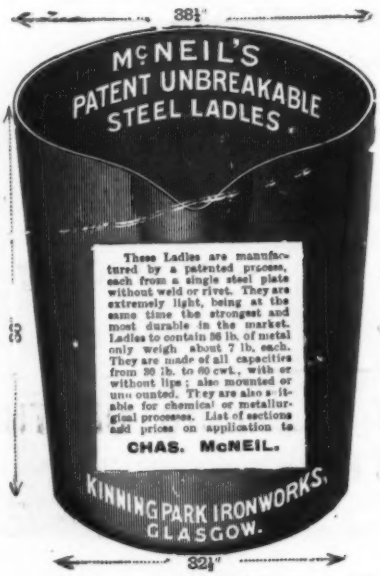
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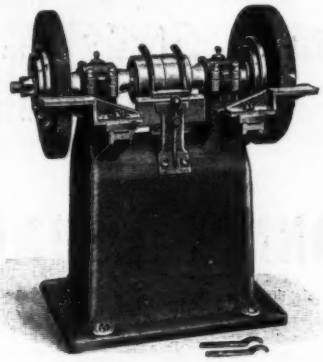

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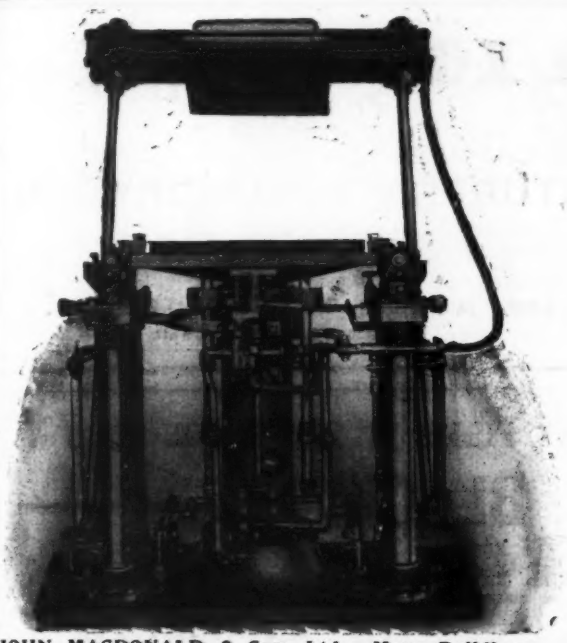

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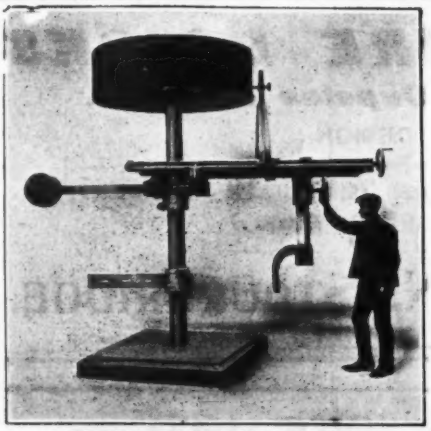

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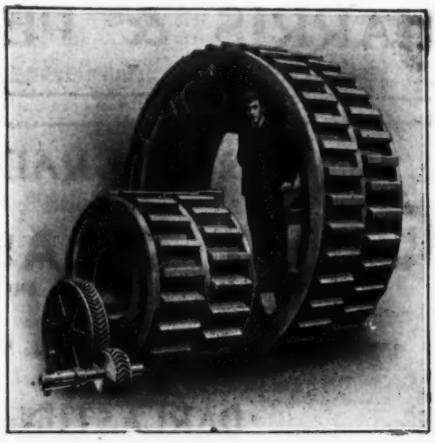

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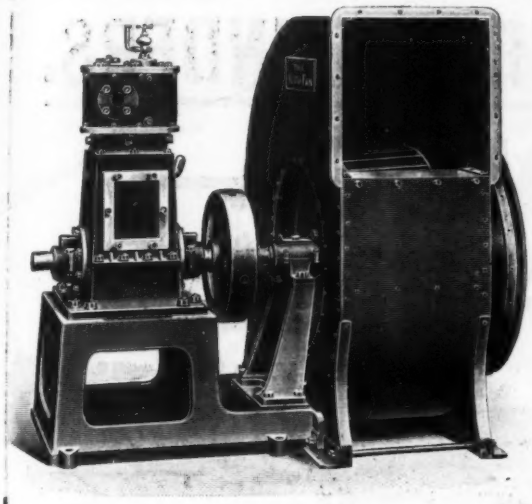

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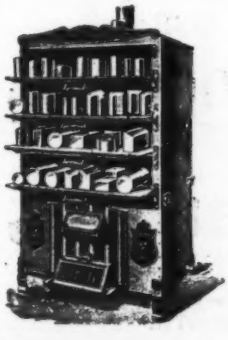

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Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director

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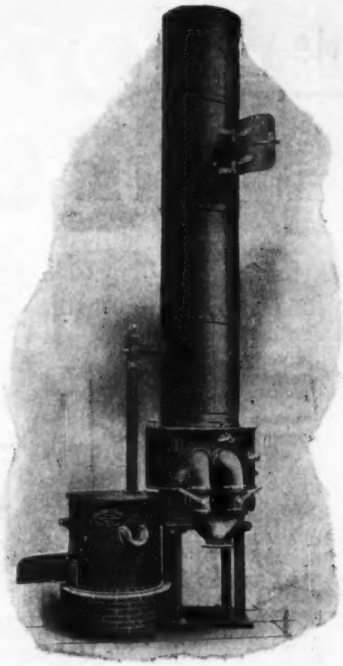

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